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AUGUST, 1872.

## THE AUGUST AND NOVEMBER METEORS.

By Dr. H. SCHELLEN.

WHOEVER has observed the heavens on a clear night with some amount of attention and patience, cannot fail to have noticed the phenomenon of a falling star, one of those well-known fiery meteors which suddenly blaze forth in any quarter of the heavens, descend toward the earth, generally with great rapidity, in either a vertical or slanting direction, and disappear after a few seconds at a higher or lower altitude. As a rule, falling stars can only be seen of an evening, or at night, owing to the great brightness of daylight; but many instances have occurred in which their brilliancy has been so great as to render them visible in the daytime, as well when the sky was overcast as when it was perfectly cloudless. It has been calculated that the average number of these meteors passing through the earth's atmosphere, and sufficiently bright to be seen at night with the naked eye, is not less than 7,500,000 during the space of twenty-four hours, and this number must be increased to 400,000,000 if those be included which a telescope would reveal. In many nights, however, the number of these meteors is so great that they pass over the heavens like flakes of snow, and for several hours are too numerous to be counted. Early in the morning of the 12th of November, 1799, Humboldt and Bonpland saw before sunrise, when on the coast of Mexico, thousands of meteors during the space of four hours, most of which left a track behind them of from 5° to 10° in length; they mostly disappeared without any display of sparks, but some seemed to burst, and others, again, had a nucleus as bright as Jupiter, which emitted sparks. On the 12th of November, 1833, there fell another shower of meteors, in which, according to Arago's estimation, 240,000 passed over the heavens, as seen from the place of observation, in three hours.

Only in very rare instances do these fiery substances fall upon the

surface of the earth; when they do, they are called balls of fire; and occasionally they reach the earth before they are completely burnt out or evaporated; they are then termed meteoric stones, aërolites, or meteoric iron. They are also divided into accidental meteors and meteoric showers, according as to whether they traverse the heavens in every direction at random, or appear in great numbers following a common path, thus indicating that they are parts of a great whole.

It is now generally received, and placed almost beyond doubt by the recent observations of Schiaparelli, Le Verrier, Weiss, and others, that these meteors, for the most part small, but weighing occasionally many tons, are fragmentary masses, revolving, like the planets, round the sun, which in their course approach the earth, and, drawn by its attraction into our atmosphere, are set on fire by the heat generated through the resistance offered by the compressed air.

The chemical analysis of those meteors which have fallen to the earth in a half-burnt condition in the form of meteoric stones proves that they are composed only of terrestrial elements, which present a form and combination commonly met with in our planet. Their chief constitutent is metallic iron, mixed with various silicious compounds; in combination with iron, nickel is always found, and sometimes also cobalt, copper, tin, and chromium; among the silicates, olivine is especially worthy of remark as a mineral very abundant in volcanic rocks, as also augite. There have also been found, in the meteoric stones hitherto examined, oxygen, hydrogen, sulphur, phosphorus, carbon, aluminium, magnesium, calcium, sodium, potassium, manganese, titanium, lead, lithium, and strontium.

The height at which meteors appear is very various, and ranges chiefly between the limits of 46 and 92 miles; the mean may be taken at 66 miles. The speed at which they travel is also various, generally about half as fast again as that of the earth's motion round the sun, or about 26 miles in a second: the maximum and minimum differ greatly from this amount, the velocity of some meteors being estimated at 14 miles, and that of others at 107 miles in a second.

When a dark meteorite of this kind, having a velocity of 1,660 miles per minute, encounters the earth, flying through space at a mean rate of 1,140 miles per minute, and when through the earth's attraction its velocity is further increased 230 miles per minute, this body meets with such a degree of resistance, even in the highest and most rarefied state of our atmosphere, that it is impeded in its course, and loses in a very short time a considerable part of its momentum. By this encounter there follows a result common to all bodies which, while in motion, suddenly experience a check. When a wheel revolves very rapidly, the axletree or the drag which is placed under the wheel is made red-hot by the friction. When a cannon-ball strikes suddenly with great velocity against a plate of iron, which constantly happens at target-practice, a spark is seen to flash from the ball even in day-

ught; under similar circumstances a lead bullet becomes partially melted. The heat of a body consists in the vibratory motion of its smallest particles; an increase of this molecular motion is synonymous with a higher temperature; a lessening of this vibration is termed decreasing heat, or the process of cooling. Now, if a body in motion, as for instance a cannon-ball, strike against an iron plate, or a meteorite against the earth's atmosphere, in proportion as the motion of the body diminishes and the external action of the moving mass becomes annihilated by the pressure of the opposing medium upon the foremost molecules, the vibration of these particles increases; this motion is immediately communicated to the rest of the mass, and by the acceleration of this vibration through all the particles the temperature of the body is raised. This phenomenon, which always takes place when the motion of a body is interrupted, is designated by the expression *the conversion of the motion of the mass into molecular action or heat;* it is a law without exception that, where the *external* motion of the mass is diminished, an inner action among its particles, or heat, is set up in its place as an equivalent, and it may be easily supposed that, even in the highest and most rarefied strata of the earth's atmosphere, the velocity of the meteorite would be rapidly diminished by its opposing action, so that shortly after entering our atmosphere the vibration of the inner particles would become accelerated to such a degree as to raise them to a white heat, when they would either become partially fused, or, if the meteorite were sufficiently small, it would be dissipated into vapor, and leave a luminous track behind it of glowing vapors.

Haidinger, in a theory embracing all the phenomena of meteorites, explains the formation of a ball of fire round the meteor, by supposing that the meteorite, in consequence of its rapid motion through the atmosphere, presses the air before it till it becomes luminous. The compressed air in which the solid particles of the surface of the meteorite glow then rushes on all sides, but especially over the surface of the meteor behind it, where it encloses a pear-shaped vacuum which has been left by the meteorite, and so appears to the observer as a ball of fire. If several bodies enter the earth's atmosphere in this way at the same time, the largest among them precedes the others, because the air offers the least resistance to its proportionately smallest surface; the rest follow in the track of the first meteor, which is the only one surrounded by a ball of fire. When by the resistance of the air the motion of the meteor is arrested, it remains for a moment perfectly still; the ball of fire is extinguished, the surrounding air rushes suddenly into the vacuum behind the meteor, which, left solely to the action of gravitation, falls vertically to the earth. The loud, detonating noise usually accompanying this phenomenon finds an easy explanation in the violent concussion of the air behind the meteor, while the generally-received theory, that the detonating noise is the result of an explosion or bursting of the meteorite, does not meet with any confirmation.

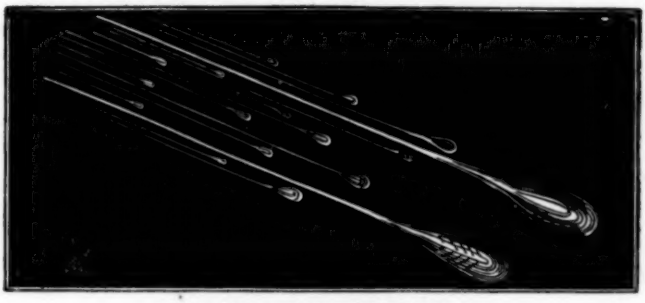
The circumstance that most meteors are extinguished before reaching the earth seems to show that their mass is but small. If the distance of a meteor from the earth be ascertained, as well as its apparent brightness as compared with that of a planet, it is possible, by comparing its luminosity with that of a known quantity of ignited gas, to estimate the degree of heat evolved in the meteor's combustion. As this heat originates from the motion of the meteor being impeded or interrupted by the resistance of the air, and as this motion or momentum is exclusively dependent on the speed of the meteor as well as upon its mass, it is possible, when the rate of motion has been ascertained by direct observation, to determine the mass. Prof. Alexander Herschel has calculated by this means that those meteors of the 9th and 10th of August, 1863, which equalled the brilliancy of Venus and Jupiter, must have possessed a mass of from five to eight pounds, while those which were only as bright as stars of the second or third magnitude would not be more than about ninety grains in weight. As the greater number of meteors are less bright than stars of the second magnitude, the faint meteors must weigh only a few grains, for, according to Prof. Herschel's computation, the five meteors observed on the 12th of November, 1865, some of which surpassed in brilliancy stars of the first magnitude, had not an average weight of more than five grains; and Schiaparelli estimated the weight of a meteor from other phenomena to be about fifteen grains. The mass, however, of the meteoric stones which fall to the earth is considerably greater, whether they consist of one single piece, such as the celebrated iron-stone discovered by Pallas in Siberia, which weighed about 2,000 pounds, or of a cloud composed of many small bodies which penetrate the earth's atmosphere in parallel paths, as shown in Fig. 1, and which, from a simultaneous ignition and descent upon the earth, present the appearance of a large meteor bursting into several smaller pieces. Such a shower of stones, accompanied by a bright light and loud explosion, occurred at L'Aigle, in Normandy, on the 26th of April, 1803, when the number of stones found in a space of 14 square miles exceeded 2,000. In the meteoric shower that fell at Kúyahinga, in Hungary, on the 9th of June, 1866, the principal stone weighed about 800 pounds, and was accompanied by about a thousand smaller stones, which were strewed over an area of 9 miles in length by 3¼ broad.

It must not be supposed, however, that the density of such a cosmical cloud is as great when out of the reach of the attraction of the sun and the earth as when its constituents fall upon the earth's surface. Schiaparelli calculates, from the number of meteors observed yearly in the month of August, that the distance between any two must amount, on the average, to 460 miles. As the cosmical clouds which produce the meteors approach the sun in their wanderings from the far-off regions of space, they increase in density some million times, therefore the distance between any two meteors, only a few grains in

weight, before the cloud begins to be condensed, may be upward of 40,000 miles.

The most striking example of such a cosmical cloud composed of small bodies loosely hung together, and existing with hardly any connection one with another, is exhibited in the meteoric showers occurring periodically in August and November. It is an ascertained fact that on certain nights in the year the number of meteors is extraordi-

FIG. 1.



Balls of Fire seen through the Telescope.

narily great, and that at these times they shoot out from certain fixed points in the heavens. The shower of meteors which happens every year on the night of the 10th of August, proceeding from the constellation of Perseus, is mentioned in many old writings. The shower of the 12th and 13th of November occurs periodically every 33 years, for three years in succession, with diminishing numbers; it was this shower that Alexander von Humboldt and Bonpland observed on the 12th of November, 1799, as a real rain of fire. It recurred on the 12th of November, 1833, in such force that Arago compared it to a fall of snow, and was lately observed again in its customary splendor in North America, on the 14th of November, 1867. Besides these two principal showers, there are almost a hundred others recurring at regular intervals; each of these is a cosmical cloud composed of small dark bodies very loosely held together, like the particles of a sand-cloud, which circulate round the sun in one common orbit. The orbits of these meteor streams are very diverse; they do not lie approximately in one plane like those of the planets, but cross the plane of the earth's orbit at widely different angles. The motion of the individual meteors ensues in the same direction in one and the same orbit; but this direction is in some orbits in conformity with that of the earth and planets, while in others it is in the reverse order.

The earth in its revolution round the sun occupies every day a different place in the universe; if, therefore, a meteoric shower pass through our atmosphere at regular intervals, there must be at the place where the earth is at that time an accumulation of these small cosmical

bodies, which, attracted by the earth, penetrate its atmosphere, are ignited by the resistance of the air, and become visible as falling stars. A cosmical cloud, however, cannot remain at a fixed spot in our solar system, but must circulate round the sun as planets and comets do; whence it follows that the path of a periodic shower intersects the earth's orbit, and the earth must either be passing through the cloud, or else very near to it, when the meteors are visible to us.

The meteor-shower of the 10th of August, the radiant point of which is situated in the constellation of Perseus, takes place nearly every year, with varying splendor; we may therefore conclude that the small meteors composing this group form a ring round the sun, and the earth every 10th of August is at the spot where this ring intersects our orbit; also that the ring of meteors is not equally dense in all parts: here and there these small bodies must be very thinly scattered, and in some places even altogether wanting.

Fig. 2 shows a very small part of the elliptic orbit which this meteoric mass describes round the sun S. The earth encounters this orbit on the 10th of August, and goes straight through the ring of meteors. The dots along the ring indicate the small dark meteors which ignite in our atmosphere, and are visible as shooting-stars. The line *m* is the line of intersection of the earth's orbit and that of the meteors; the line P S shows the direction of the major axis of their orbit. This axis is fifty times greater than the mean diameter of the earth's orbit; the orbit of the meteors is inclined to that of the earth at an angle of 64° 3′, and their motion is retrograde, or contrary to that of the earth.

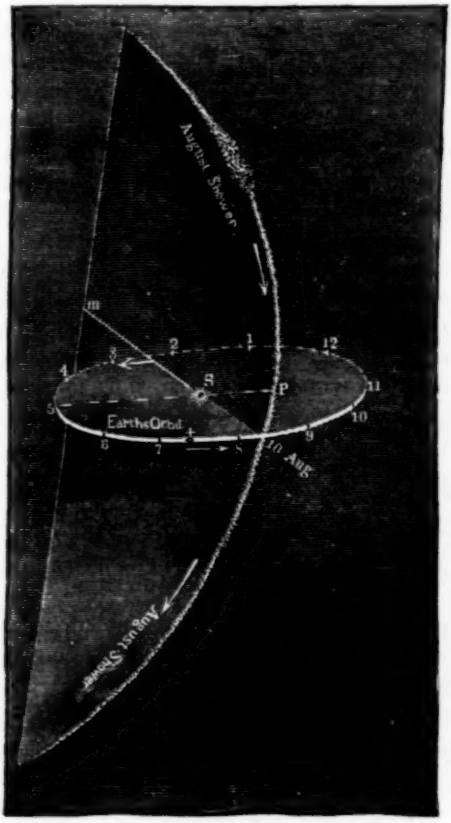
The November shower is not observed to take place every year on the 12th or 13th of that month, but it is found that every 33 years an extraordinary shower occurs on those days, proceeding from a point in the constellation of Leo. The meteors composing this shower, unlike the August one, are not distributed along the whole course of their orbit, so as to form a ring entirely filled with meteoric particles, but constitute a dense cloud, of an elongated form, which completes its revolution round the sun in 33 years, and crosses the earth's path at that point where the earth is every 13th of November.

When the November shower reappears after the lapse of 33 years, the phenomenon is repeated during the two following years on the 13th of that month, but with diminished splendor; the meteors, therefore, extend so far along the orbit as to require three years before they have all crossed the earth's path at the place of intersection; they are, besides, unequally distributed, the preceding part being much the most dense.

A very small part of the elliptic orbit, and the distribution of the meteors during the November shower, is represented in Fig. 3. As shown in the drawing, this orbit intersects that of the earth at the place where the earth is about the 14th of November, and the motion of the meteors, which occupy only a small part of their orbit, and are

very unequally distributed, is retrograde, or contrary to that of the earth. The inclination of this orbit to that of the earth is only 17° 44′; its major axis is about 10½ times greater than the diameter of the earth's orbit, and the period of revolution for the densest part of the meteorites round the sun S is 33 years 3 months.

Fig. 2.




Orbit of the Meteor-Shower of the 10th of August.

From all we have now learned concerning the nature and constitution of comets, nebulæ, cosmical clouds, and meteoric swarms, an unmistakable resemblance will be remarked among these different forms in space. The affinity between comets and meteors had been already recognized by Chladni, but Schiaparelli, of Milan, was the first to take account of all the phenomena exhibited by these mysterious heavenly bodies, and with wonderful acuteness to treat successfully the mass of observations and calculations which had been contributed during the course of the last few years by Oppolzer, Peters, Bruhns, Heis, Le

Verrier, and other observers. He not only shows that the orbits of meteors are quite coincident with those of comets, and that the same object may appear to us at one time as a comet, and at another as a shower of meteors, but he proves also by a highly-elegant mathematical calculation that the scattered cosmical masses known to us by the name of nebulæ would, if in their journey through the universe they were to come within the powerful attraction of our sun, be formed into comets, and these again into meteoric showers.

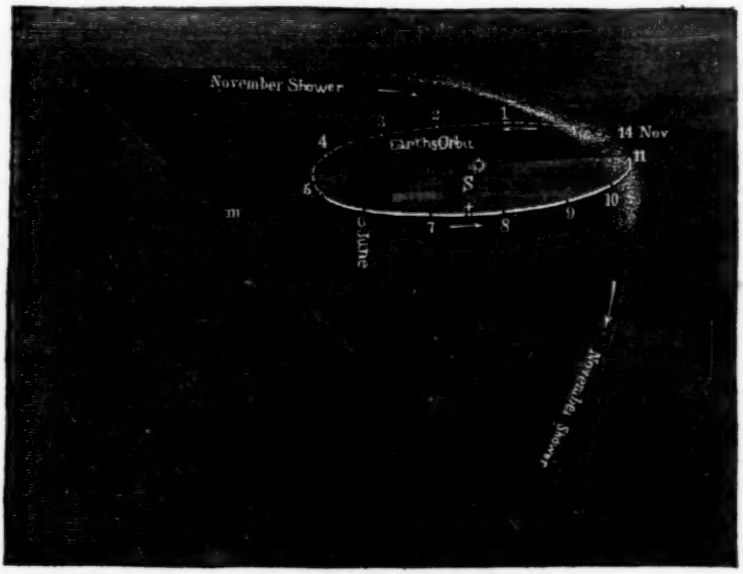
We should be carried away too far from our subject were we to enter fully into the consideration of this bold and ingenious theory of the Milan astronomer, supported though it be by a series of facts; but while we refer the reader to vol. xx. of "Naturwissenschaftlichen Volksbücher," by A. Bernstein, in which this subject, "die Räthsel der Sternschnuppen und der Kometen," is fully treated of in a very clear and attractive manner, we shall confine ourselves to the following short statement of Schiaparelli's theory:

Nebulæ are composed of cosmical matter in which as yet there is no central point of concentration, and which has not become sufficiently dense to form a celestial body in the ordinary sense of the term. The diffuse substance of these cosmical clouds is very loosely hung together; its particles are widely separated, thus constituting masses of enormous extent, some of which have taken a regular form, and some not. As these nebulous clouds may be supposed to have, like our sun, a motion in space, it will sometimes happen that such a cloud comes within reach of the power of attraction of our sun. The attraction acts more powerfully on the preceding part of the nebulæ than on the farther and following portion; and the nebula, while still at a great distance, begins to lose its original spherical form, and becomes considerably elongated. Other portions of the nebulous mass follow continuously the preceding part, until the sphere is converted into a long cylinder, the foremost part of which, that toward the sun, is denser and more pointed than the following part, which retains a portion of its original breadth. As it nears the sun, this transformation of the nebulous cloud becomes more complete: illuminated by the sun, the preceding part appears to us as a dense nucleus, and the following part, turned away from the sun, as a long tail, curved in consequence of the lateral motion preserved by the nebula during its progress. Out of the original spherical nebula, quite unconnected with our solar system, a comet has been formed, which in its altered condition will either pass through our system to wander again in space, or else remain as a permanent member of our planetary system. The form of the orbit in which it moves depends on the original speed of the cloud, its distance from the sun, and the direction of its motion, and thus its path may be elliptical, hyperbolical, or parabolical; in the last two cases, the comet appears only once in our system, and then returns to wander in the realms of space; in the former case, it abides with us, and accomplishes

its course round the sun, like the planets, in a certain fixed period of years. From this it is evident that the orbits of comets may occur at every possible angle to that of the earth, and that their motion will be sometimes progressive and sometimes retrograde.

The history of the cosmical cloud does not, however, end with its transformation into a comet. Schiaparelli shows in a striking manner that, as a comet is not a solid mass, but consists of particles, each possessing an independent motion, the head or nucleus nearer the sun must necessarily complete its orbit in less time than the more distant portions of the tail. The tail will therefore lag behind the nucleus in

FIG. 8.




Orbit of the November Meteor-Shower.

the course of the comet's revolution, and the comet, being more and more elongated, will at last be either partially or entirely resolved into a ring of meteors. In this way the whole path of the comet becomes strewed with portions of its mass, with those small, dark meteoric bodies which, when penetrating the earth's atmosphere, become luminous, and appear as falling stars. Instead of the comet, there now revolves round the sun a broad ring of meteoric stones, which occasion the phenomena we every year observe as the August meteors. Whether this ring be continuous, and the meteoric masses strewed along the whole course of the path of the original comet, or whether the individual meteors, as in the November shower, have not filled up entirely the whole orbit, but are still partially in the form of a comet,

is, in the transformation of a cosmical cloud through the influence of the sun, only a question of time; in course of years the matter composing a comet which describes an orbit round the sun must be dispersed over its whole path; *if the original orbit be elliptical, an elliptic ring of meteors will gradually be formed from the substance of the comet, of the same size and form as the original orbit.*

Schiaparelli has, in fact, discovered so close a resemblance between the path of the August meteors and that of the comet of 1862, No. III., that there cannot be any doubt as to their complete identity. The meteors to which we owe the annual display of falling stars on the 10th of August are not distributed equally along the whole course of their orbit; it is still possible to distinguish the agglomeration of meteoric particles which originally formed the cometary nucleus from the other less dense parts of the comet; thus, in the year 1862 the denser portion of this ring of meteors through which the earth passes annually on the 10th of August, and which causes the display of falling stars, was seen in the form of a comet, with head and tail as the densest parts, approached the sun and earth in the course of that month. Oppolzer, of Vienna, calculated with great accuracy the orbit of this comet, which was visible to the naked eye. Schiaparelli had previously calculated the orbit of the meteoric ring to which the shooting-stars on the 10th of August belong before they are drawn into the earth's atmosphere. The almost perfect identity of the two orbits justifies Schiaparelli in the bold assertion that *the comet of* 1862, No. III., *is no other than the remains of the comet out of which the meteoric ring of the* 10*th of August has been formed in the course of time.* The difference between the comet's nucleus and its tail that has now been formed into a ring, consists in that, while the denser meteoric mass forming the head approaches so near the earth once in every 120 years as to be visible in the reflected light of the sun, the more widely-scattered portion of the tail composing the ring remains invisible, even though the earth passes through it annually on the 10th of August. Only fragments of this ring, composed of dark meteoric particles, become visible as shooting-stars when they penetrate our atmosphere by the attraction of the earth, and ignite by the compression of the air.

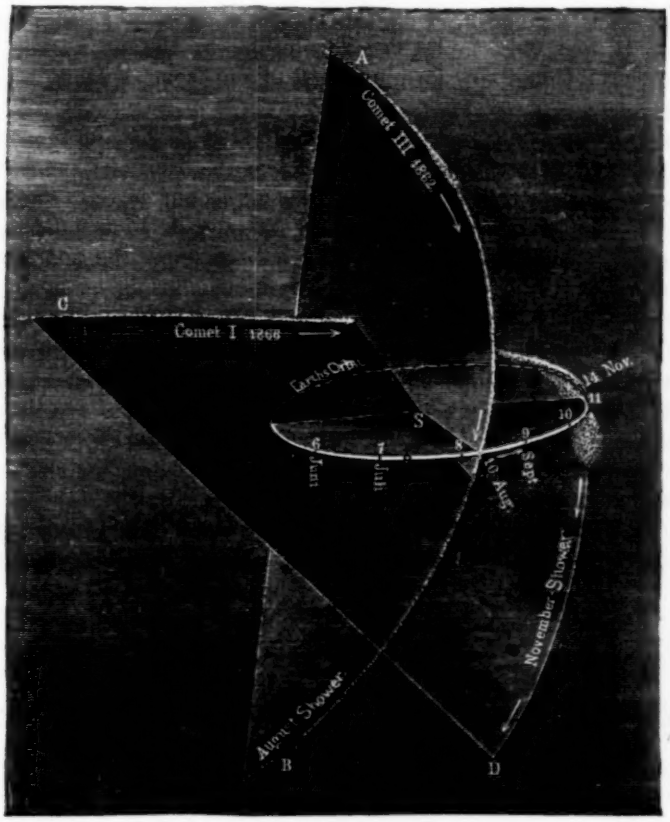
A cloud of meteors of such a character can naturally only be observed as a meteor-shower when in the nodes of its orbit—that is to say, in those points where it crosses the earth's orbit—and then only when the earth is also there at the same time, so that the meteors pass through our atmosphere. The nebula coming within the sphere of attraction of our solar system would, at its nearest approach to the sun (perihelion), and in the neighboring portions of its orbit, appear as a *comet*, and when it grazed the earth's atmosphere would be seen as a *shower of meteors.*

Calculation shows that this ring of meteors is about 10,948 millions of miles in its greatest diameter. As the meteoric shower of the 10th

of August lasts about six hours, and the earth travels at the rate of eighteen miles in a second, it follows that the breadth of this ring at the place where the earth crosses it is 4,043,520 miles. In Fig. 4, A B represents a portion of the orbit of the comet of 1862, No. III., which is identical with that (Fig. 2) of the August shower.

The calculations of Schiaparelli, Oppolzer, Peters, and Le Verrier, have also discovered the comet producing the meteors of the Novem-

FIG. 4.




Orbits of the August and November Meteor-Showers.
(Orbits of Comets III., 1862, and I., 1866.)

ber shower, and have found it in the small comet of 1866, No. I., first observed by Tempel, of Marseilles. Its transformation into a ring of meteors has not proceeded nearly so far as that of the comet of 1862, No. III. Its existence is of a much more recent date; and, therefore, the dispersion of the meteoric particles along the orbit, and the consequent formation of the ring, is but slightly developed.

According to Le Verrier, a cosmical nebulous cloud entered our

system in January, A. D. 126, and passed so near the planet Uranus as to be brought by its attraction into an elliptic orbit round the sun. This orbit is the same as that of the comet discovered by Tempel, and calculated by Oppolzer, and is identical with that in which the November group of meteors make their revolution.

Since that time, this cosmical cloud, in the form of a comet, has completed fifty-two revolutions round the sun, without its existence being otherwise made known than by the loss of an immense number of its components, in the form of shooting-stars, as it crossed the earth's path in each revolution, or in the month of November in every 33 years. It was only in its last revolution, in the year 1866, that this meteoric cloud, now forming part of our solar system, was first seen as a comet.

The orbit of this comet is much smaller than that of the August meteors, extending at the aphelion as far as the orbit of Uranus, while the perihelion is nearly as far from the sun as our earth. The comet completes its revolution in about 33 years and three months, and encounters the earth's orbit as it is approaching the sun toward the end of September. It is followed by a large group of small meteoric bodies, which form a very broad and long tail, through which the earth passes on the 13th of November. Those particles which come in contact with the earth, or approach so near as to be attracted into its atmosphere, become ignited, and appear as falling stars. As the earth encounters the comet's tail, or meteoric shower, for three successive years at the same place, we must conclude the comet's track to have the enormous length of 1,772,000,000 of miles. In Fig. 4, C D represents a portion of the orbit of this comet which is identical with the orbit (Fig. 3) of the November meteors.—*Spectrum Analysis.*

## MODERN LITERATURES IN THE HIGHER EDUCATION.

By Dr. J. B. MOZLEY,

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THERE is no one who, coming for the first time to a knowledge of our English system of education, would not be very much surprised by the fact that, while we take the greatest trouble to instruct young men in the language, history, and institutions of nations that lived two thousand years ago, and whose whole being belongs to a past stage in the world's existence, we take no trouble at all to instruct them concerning the nations who now live, with whom we have an every-day intercourse, on whom we depend for so many benefits, as well material as spiritual, whose temper, character, and friendly or inimical

feelings toward us are of the very highest importance. If we can imagine such a person giving free expression to his feelings at the first sight of such a phenomenon (a phenomenon observable in all other European states equally with our own), what he would say would probably be something after this manner: "These nations of Europe present some very singular anomalies. Their newspapers, of whatever country, are full of complaints of the absolute inability of all foreigners to gain the least comprehension of the institutions of that particular country. The English and Germans alike speak of the French as a nation wholly swallowed up in themselves, and ludicrously ignorant of every thing outside themselves. The French retaliate by calling the Germans barbarians and the English shopkeepers. The Americans say that no foreigner, except a certain De Tocqueville, has ever gained the smallest glimpse of their character; while the English affirm that the Americans themselves are blinded to every thing except what they think their national grandeur. And what is more," the observer might go on to remark, "these complaints are, for the most part, not only true, but obvious, and obviously disastrous in their results. Witness the fact that the leading English newspaper, not many years ago, inserted a leading article on what turned out to be an absurd mistake of its own respecting one of the chief institutions of Germany—the Zollverein—a mistake which it had to acknowledge the day after. Or, again, witness the fact that one of the chief French authors can hardly employ an English word in his books without a ludicrous misspelling. Or, again, the more serious fact that the French enter upon a war in the firm belief that they will find allies in the States of South Germany; instead of which, they find them enthusiastic enemies. This being the case," he might conclude by saying, "I naturally looked to those bodies in these countries whose office it is to attain and diffuse knowlenge to the widest degree possible—the universities—assuming that the means of remedying so great a defect in knowledge, and one so universally complained of, would at any rate be under their consideration. To my surprise, I find that they had hardly even noticed the subject at all. Every one of these nations seemed to me to be in the position of a man whose whole time was occupied in investigating the biography of his great-grandfather, while with his relations, connections, friends, and acquaintances, he only transacted the most barely necessary business for the shortest possible space of time."

An observer who spoke in this way would, it may be granted, be speaking in ignorance of many of the causes of the phenomenon he wondered at, and of the practical necessities that might be held to justify it. But he would surely not have in the least exaggerated the strangeness of the phenomenon. Every conceivable branch of knowledge—physical science, mathematics, philosophy, theology—all ancient culture, is thought in England worth systematic study, except this. It is only the condition, material and spiritual, of the nations with whom

we come into immediate contact, whose disposition toward us constantly elicits from us the greatest interest and anxiety, that we do not think worthy of systematic study. It is of this alone that we are notoriously ignorant.

The best way, perhaps, of appreciating how wide the extent of this ignorance is, will be by considering how great is the variety of knowledge which an Oxford or Cambridge first-class man will often possess respecting the whole national being of Greece and Rome. To begin with, he will know the whole political development of those countries; he will trace with accuracy the consistent progress of Athens to an equal liberty among her citizens, through Solon, Cleisthenes, Aristides, Pericles; he will know by what causes she finally fell from her strength and supremacy. From Demosthenes, he will know a good deal of the nature of her laws, in their application to the manifold interests of men —to the injuries which one man may suffer from another, in person or property, by fraud or violence. He will know something from the same source of the way in which the rich Athenians managed their properties, of the number of their slaves, of their commerce, of their loans. He will know how the Athenian navy was provided and kept up, what was the pay of the sailors, how they manœuvred against the enemy. He will be intimately acquainted with every incident in the external history of Athens; and in the geography of Greece he will know the situation of the minutest villages, the least important islands. All the varied history of the Greek colonies, and their relations to their respective mother-cities, will be familiar to him. Besides this, he will know how the Greeks themselves felt, thought, and theorized, on all these matters of their national existence; he will have read the "Republics" of Plato and of Aristotle; he will be no stranger to their religious feelings, or to their deepest speculations in philosophy. Finally, in their poetry—epic, tragedy, or comedy—he will have felt the flow of their fancy and imagination. All this, and much more, our first-class man will be in a position to know about Greece; and in Rome he will have no less rich a field of information; for, if the philosophy and poetry of Rome do not possess an equal interest with those of Greece, the law, politics, and military system of Rome possess much more.

Such and so great a thing is it to know the whole being of a nation. And this knowledge is actually held by no inconsiderable number of people in England; and there are many more who, though they do not have it at their fingers' ends, would yet be readily able, by means of excellent text-books and their own previous knowledge, to test in half an hour any random assertions respecting the ancients made by an incompetent authority.

Now, let it be considered that there are five modern nations—England, France, Germany, Italy, and Spain—who have each a history of equal length with the authentic history of Greece or Rome, a literature (at least in the first four cases) not greatly inferior, institutions and a

manner of life far more complex, and it will be admitted that here we have a subject well worthy of systematic and regular treatment. These are not topics that can be handled satisfactorily in the idle leisure of a summer tour, in a long vacation. They deserve that a far more steady attention should be devoted to them. Let this first be recognized fully—the importance, which cannot be exaggerated, of a kind of study in which no man in England has had a regular training—and then we may proceed to consider the method by which this study may be raised to the prominence which it deserves. That there are difficulties in the way of its assuming this position is not to be denied. It will be the endeavor of the present essay to remove, not the whole of these difficulties, but so many of them as bar the way to any practical consideration of the subject in its entirety.

First, however, it is necessary to consider what is actually done at our schools and universities toward giving students a knowledge of modern languages and literatures. It is a little curious that the question excites more attention in relation to schools than in relation to the universities. Already, there is hardly any (if any) school of high rank in the country in which French, at least, does not form a regular part of the instruction. Whereas at the universities there are only incidental exceptions to the general neglect with which the subject is treated. And this very fact shows that the whole significance of the question is misunderstood. As languages, French and German (especially the former) are less powerful instruments of training, for the abler boys, than Latin and Greek. As literatures—that is, as summing up the whole thought and history of a nation—they would, if properly managed, be much more powerful instruments (in proportion to the much greater variety of modern life as compared with ancients), and are, besides, much more important for us to know. Now, schoolboys have more need to apply themselves to languages as languages than to the wide field of information comprised in a literature; for linguistic study gives a constant yet not too fatiguing exercise to the intellect, an exercise quite indispensable in the first formation of the mind, without demanding on the part of the student any experience of actual realities. And this is the principal benefit gained at present in schools by the study of French and German, that the slower boys have something more within the range of their capacity than they had formerly; a benefit which, though it may in time receive augmentation, is in itself no inconsiderable gain. At the universities, however, the importance of linguistic study, as compared with material study, is much less. A youth of twenty will have the fibre of his mind, his actual mental grasp and capacity, in a great measure, determined; it is not so important, though it is not unimportant, that he should be subjected to an incessant intellectual stimulus. On the other hand, he will now begin for the first time to take an interest in a variety of topics; knowledge will seem to him worth acquiring for its own sake;

and it is very important that his researches should be rightly directed. In a word, he is now ripe for understanding, or beginning to understand, more than a language—a literature, or the records of a nation. That he is ripe for so much as this is obvious from the fact that the students at our universities do learn more than the mere Latin and Greek of the classics—they learn the subject-matter of the books; and this, especially at Cambridge, is taking place more and more. When, then, we see that modern languages are studied at schools, and not at the universities, it is obvious that the question respecting them has been very incompletely apprehended; it has been quite forgotten that they are connected with a very wide and important field of knowledge.

It is, therefore, the study of modern literatures rather than the study of modern languages that is here discussed; and for this reason the question relates rather to universities than to schools. Let us, then, consider what is the value of those incidental exceptions to which allusion was made just now; what, in short, is the actual amount of instruction in modern periods given at the universities. In such examinations as the law and modern history examination at Oxford, the law tripos and the moral science tripos at Cambridge, a good deal of acquaintance with certain aspects of modern times is required. And there have been at Cambridge, at different times, proposals for a history tripos, to comprise all history, ancient and modern; proposals which, however, did not obtain any large acceptance, and were, perhaps, rather made by those who wished to see the historical element eliminated from the classical tripos than by those who wished to see it introduced anywhere else.

Those, however, who think that any or all of the examinations above-mentioned will give those who prepare for them an adequate acquaintance with the nations of the modern world, take a very mechanical view of that which is meant by a nation. Nations, like individuals, or rather much more than individuals, extend far beyond any particular line of their action. The most accurate student of the law and philosophy of modern times will not thereby know any thing about military, commercial, and educational systems. Nor is it reasonable to think that there can be a separate course of study for each separate branch of national existence. The branches are much too numerous; it is necessary that all but the few that are of most extreme importance should be combined in a general system, having its centre in that which is the voice of the nation, in that which comes nearest to the very heart and being of the nation, namely, the literature. It is quite possible in such a mode of study to go far beyond the mere *littérateur*, the dabbler in criticism and politics. However much it be true that the literature must be the centre, yet that the researches of the student should stop with the literature need not and ought not to be the case. To take a single instance from English authors. How full is Milton, both in his prose works and in his poetry, of allusions to

the persons, circumstances, and problems of his time! how far less likely are these to be forgotten, how much more vividly must they come before us, if connected with the thoughts of a great man, than if learned in the bare lines of a history! Or, to come to a still more special example, the "Areopagitica" opens out into a world of inquiries respecting the growth of freedom of speech in England, to enter upon which is certainly no superficial thing. Milton is, no doubt, exceptional among authors for the closeness of his connection with the total life of his country. But Schiller, from his ardent patriotism, would not come far behind him; and even in the more artistic Goethe many links of the kind could be found.

By nothing which is said here is there intended to be implied the slightest disparagement of the examinations in law and philosophy at Oxford and Cambridge, or the least idea that it is possible to supply their place by a more general examination in modern literatures. Law and philosophy, like science, are subjects that cannot be studied otherwise than on their own basis; they demand a stringent rigidity of consecutive reasoning that is wholly alien from the wide knowledge and free play of the mind that deals with literatures, whether ancient or modern; moreover, the treatment of them cannot be limited to modern times, deriving, as they do, their origin, the one from Greece, the other from Rome. But history stands on a different ground; and that it is felt so to stand may be seen by the difficulty which has lately been experienced at Cambridge in assigning a place to modern history among the other studies. A few years ago it was united in an incongruous tie with metaphysics, political economy, and jurisprudence; now, by a decision which certainly cannot be thought unwise, it has dropped out of this connection; but, though it has sought admission in many quarters, it is up to this day excluded from the honor examinations of the university. And the reason is clear. Pure historical study does not try the intellect very deeply; the subjects with which it deals are so various that it cannot bestow on any of them more than a somewhat superficial glance. There are, of course, special kinds of history that may go deeply into special subjects, of which Hallam's work is an example; but these, by the very fact of their being special, are narrow; nor is it possible to make of any of them a backbone whereto the immense number of topics comprised in an ordinary history, geography, military service, the personal character of statesmen, theological disputes, artistic progress, etc., would naturally attach themselves. The authors of a nation are the natural centre of the history of the nation. To know a man it is necessary to hear what he says with his own mouth, as well as what others have to record about him; and in the same way the history of a nation is an insufficient means of getting acquainted with that nation, unless it be supplemented by that more intimate acquaintance implied in a knowledge of its authors.

Thus there are two lines of argument which meet in the same conclusion. There is a kind of study—namely, the study of modern literatures—which is neglected at the universities, because it is not seen that there is substance enough in it to give matter for an examination. There is a kind of study—namely, modern history—which it has been eagerly sought to introduce at the universities, which has an even too great abundance of matter, but which is cast out because it wants some thread of unity to run through the whole. Is it not clear that the two belong to each other?—that they ought to be studied side by side? And, indeed, this is what is actually done by the student of Latin and Greek.

In fact, what is here proposed, is an examination to run precisely parallel to the classical tripos at Cambridge, or the final classical examination at Oxford. There is no great depth in an ordinary first-class man's knowledge of Plato and Aristotle; neither would there be any great depth in the knowledge of Descartes and Machiavelli possessed by the first-class man in this proposed examination. But the knowledge attained would be miles above utter ignorance, and it would form a public opinion, which, though not deep itself, would be capable of judging of depth, and distinguishing true merit from pretentious talk. Is not this very sadly wanted at the present day? Let the reader think what is the average knowledge of modern authors, modern history, and the institutions of foreign countries, possessed by his personal friends. It is pretty safe to say that it will be found very small indeed. The German or French works, which it is politely assumed that "every one" has read, will turn out perhaps to have been read by one out of every ten well-educated men. There are many who lament their ignorance, but yet, owing to the press of work in active life, cannot remove it. Is it not a hardship that they should not have had an opportunity of removing it in the course of their education? Very few people, when they have settled into a sphere of work, are able, even when they go abroad for their holidays, to do much beyond walking and seeing celebrated sights.

No doubt, an examination in modern literatures would differ in some material respects from an examination in ancient literatures. The languages being less hard, there would be less in them of a stringent intellectual test. Yet this is a difference too often exaggerated as to its extent. The difficulties which lie at the threshold of French and German are considerably less than those which lie at the threshold of Latin and Greek. But the idiosyncrasies of authors furnish a species of difficulty independent of the structure of the language. This species is, indeed, in the case of French authors, reduced to a minimum by the admirable lucidity of their style. But in German authors difficulties of this kind are even considerably above what they are in Latin and Greek. The thoughts of Richter lie less on the surface than those of Tacitus. And, in such works as political or legal orations, no easi-

ness of the language can take away the inherent complexity of the subject. However, were it even granted that for the best men Latin and Greek, as being harder in their grammar, are better instruments of training, does it follow that French, German, and Italian, should be neglected altogether? In point of the variety of the knowledge connected with them, they stand above Latin and Greek; and it may be suspected that even their comparative easiness as languages would benefit some men, who, though possibly of very sufficient ability, have not the linguistic faculty very strong. Mathematics are even a more severe intellectual gymnastic than Latin and Greek; but the superior variety of knowledge connected with the classical languages is considered to make them not inferior as means of education. The same argument, taken a step further, serves to defend modern literatures from the charge brought against them in this point of view. But, at the worst, let them, in the distribution of the prizes of the university, be considered inferior; not, therefore, as of no account whatever.

A frequent objection to the proposal here made is the advantage it would give to those who had happened to have been educated abroad. The stress sometimes laid on this objection is quite ludicrous. The advantage is one analogous to that which richer men have over poorer, in being able to command the services of better instructors. It would, however, be considerably diminished by the fact that, in such an examination, more regard must necessarily be paid to substance than to style or language. And if the effect were that of inducing parents to take all possible means of giving their children an early acquaintance with foreign languages, could this be said to be a bad result?

It is probable that modern literatures would require a greater exercise of judgment in the examiner than Latin and Greek. They verge more on controversial questions; it is more easy in them to win credit for a petty sharpness, a flimsy mode of dealing with great subjects. But this is merely a danger which it is needful to point out, not a solid and final objection.

This is not the place to discuss what should be the precise form of an examination in modern literatures. Of course, definite authors would have to be selected by the university; it would be impossible to leave the student to wander at his own sweet will over George Sand, Alfred de Musset, and Heinrich Heine—the kind of authors which, it is to be guessed, are more read than any other by the present students of French and German. Of these definite authors, some might be permanent, others changed every year. Then, as to the composition in modern languages; this, it is probable, would take the form as much of essays on special points connected with the authors read, as of direct translation into those languages. English literature and composition would itself come in for a share in the curriculum; and it is possible some modern Latin works might be admitted, as those of Erasmus or Reuchlin. Experience would guide toward the right mode

of treatment; nor is it to be expected that every thing would drop into its place neatly at once. It is not unnecessary to say this, for every one connected with our universities knows the severe criticism which new schemes have to undergo, when they do not do what it is absolutely impossible that they should do—namely, start at once in as full perfection as systems that have been matured for many generations.

It has been assumed, throughout this essay, that the best way of introducing the study of modern literatures into the universities is to establish them as a subject wholly distinct from the ancient literatures. Some might think that the two courses might beneficially be amalgamated; but on the whole it seems an unnecessary risk to endanger old and well-established systems by an extensive and violent intrusion of unproved and untried material.

In conclusion, as the course of instruction here advocated involves a smaller amount of intellectual sharpening, and a larger and more various acquisition of positive knowledge, than the generality of the systems in use at the present day, it will not be beside the point to observe that the tendency of modern education has for four centuries been in this direction—that is, rather to encourage wealth and variety of mental possessions, than extreme acuteness in their employment. Not that mental acuteness is not cultivated at the present day as much as ever it was; for putting a point on the mind, nothing can excel the mathematical course at Cambridge. But the value assigned to width of knowledge has increased in a much greater ratio, as will be plain by looking back a little in European history. The Schoolmen were in modern times the earliest educationalists of Europe. Their educational system was like their philosophy—the most simply, purely, and nakedly intellectual that the world has ever seen. They paid no regard to the storing of the mind with material, to the preparation of it for efforts to which it was at present unequal, to the laying broad foundations of fact and experience, not for the sake of immediate argument, but as food to be gradually appropriated and assimilated in the insensible silent workings of the growing man. They made men discuss. They were like a person who should expect a plant to grow by its own intrinsic power, without the nutriment of earth and water. They put the greatest strain on the intellect; but they did not bid the student to know. It was the revival of the classical literatures, and especially of Greek literature, that produced the first step in advance from this state of things. With them a flood of experience, novel, exciting, and illuminating, was poured upon the world. Nor was it long afterward that the great discoveries in mathematics and astronomy opened out a vast sphere of fresh knowledge in another direction. So vigorous an outburst could not be gainsaid. The intellect of the student was no longer left isolated; it was brought in contact with human action, the material world, and substantial

reality. Educated men were no longer disputative machines; they were invigorated by the records of noble actions, they caught again the fire of orators long since dead, they felt what it must have been to live in the Athens of Pericles and Plato, or in the Rome that withstood the victorious army of Hannibal; or, turning to modern times, they saw in the new-born science of the age that which excited the highest curiosity and hope. That complete severance and sharp-dividing line which lay between the men of speculation and the men of action in the Middle Ages was annulled in the sixteenth century; to the immense advantage of both, and has never since been revived. But, since the sixteenth century, there has been a fresh development of science, a fresh creation of noble literature. Science is sure to have its advocates, and to them it may safely be left. But shall we make no systematized effort to reap the full benefit of the writings of those great authors, the lives of those transcendent statesmen, soldiers, and discoverers by land and sea, that have adorned the annals of Europe since the birth of its present order? It is incredible that we should not. And few, indeed, must they be who have not reason to lament that they have not been furnished with better means for acquainting themselves with that whole family of nations among whom our lives are cast. We walk in the dark at present, and, as any one may know who considers our recent political history, with tottering feet and uncertain steps. Surely no further argument can be necessary to prove that all knowledge which tends to throw light on our national relations is a most important acquisition.

And all our schools, all our educational bodies, except the old universities, are doing their best to remedy these our present defects. But the universities are the keystone of the whole system; all training to which they do not give the final touch is defective and aimless; and, governed as they are by men of the highest ability and experience, it stands to reason that they have advantages for organizing a scheme of instruction which no ordinary school-master can have. Heavy are the difficulties which oppose the cultivation of modern languages, even in schools which take them up most zealously. Is it not the inevitable conclusion that the universities are imperatively bound to supply some central system of instruction in modern literatures?—*Contemporary Review.*

## THE NUTRITIVE SALTS OF FOOD.

By Prof. VOIT.

[ABSTRACT OF VOIT'S REPORT, BY M. ANDRÉ SANSON.]

IN order to understand the importance of the nutritive salts in food, we must first ascertain how far its mineral elements are nutritious, how far they are indispensable, and when they may be considered as in excess.

The investigations of Liebig, who first studied this question, and those of his school, demonstrate that certain salts are closely combined with the other elements of living bodies, forming integral parts of them. In all the tissues of the organism is found potash in combination usually with phosphoric acid. In the blood the salts of soda predominate. When we reduce the organs to ashes, these vary but very little in quality or in quantity. It is unquestionable that without these salts no organ is developed, and that there is no secretion by the glandular cellules. All the secretions contain certain salts, most of them characteristic. These salts have definite functions to discharge in the animal economy. Still, we do not know the quantity of these salts which must enter into the food, to support the body, though this is a highly-important question in the hygiene of alimentation. Direct experiments alone could decide, for Voit shows that those made by Magendie, and which are so frequently referred to, do not establish the points they are supposed to establish. Recent studies upon the nutritive value of gelatine have shown that Magendie failed to take into account some of the principal points of the question he was considering.

"For a long time," says Voit, "it had been my purpose to ascertain by thorough experimentation the value of salts in nutrition, with a view to examining how long an animal could live without them, and what symptoms it would manifest. For this purpose I had accumulated a quantity of the residuum of meat-extract. In the mean time appeared a remarkable work by Kemmerich, in which were proposed other questions, having a bearing, in many respects, upon those I had proposed to myself. Kemmerich starts out with the supposition, which Liebig, too, admits, that the residuum of the meat, without the extract, has no value as nutriment. According to his investigations, the action of meat-extract is attributable to the potash it contains, whence he concludes that the residuum is of no value for nutrition, owing to the absence of the potash. He therefore attempted to utilize it by adding to it the salts contained in meat. To this moist residuum, three times exhausted by boiling, he adds an artificial mixture of the salts of meat and common table-salt; and on this food exclusively he fed two dogs six weeks old, they devouring it ravenously. The experiment was continued for three months, and at the end of that period the dogs had gained considerably in weight."

Kemmerich repeated his experiments on the same animals, giving them now the residuum without the mixture of salts. He now observed that the animals consumed less and less from day to day, even when suffering from hunger. Again, experimenting on two dogs six weeks old, he fed to the one the residuum mixed with the salts; to the other the residuum mixed only with common table-salt. After twenty-one days a wide difference was observable between the two animals. The first one weighed much more than the second, was stronger and more intelligent. The second one had gained a little in weight, it is

true, but his condition was pitiable. He could hardly walk; his eyes were dull and expressionless; his body appeared emaciated, and he took his food reluctantly and without relish.

Voit here makes an objection to the conclusions drawn by Kemmerich; but his objection is not valid, because he does not advert to the fact that the dogs in question, owing to their age, must necessarily gain considerably in weight. His objection would hold good only in the case of full-grown animals. However, to remove all doubt as to the increase of weight when the salts of meat are added to the residuum, Kemmerich gave the second dog the residuum with these salts; and to the first dog the same, with table-salt only; the quantity of residuum being in both cases equal. The result was, that the dog which had before got only common salt, now gained much faster than the other, which latter, however, gained 530 grammes in thirty-two days.

There is no need to give in full Voit's argument on the results of Kemmerich's experiments. It is enough for us to state, with Voit, that these experiments demonstrate the fact that a carnivorous animal can live on meat-residuum, provided that there be added to it the salts of meat and common salt. Still, these experiments do not answer the principal questions we have put, viz., How long can an adult organism live without salts? and, What are the symptoms they manifest, when thus deprived? So the attempt was made to study, in adult animals, the changes that occur in albuminoid substances, when the salts are extracted.

Dr. J. Zörster made the experiments. The purpose was to sustain animal life as long as it was possible, on food very poor in salts. The animals experimented upon were never given albuminous substances alone, but always mixed with a sufficient quantity of non-nitrogenous elements, such as fat, starch, or sugar. The albuminate employed was the residuum of meat dried in the oven, pulverized, and then boiled three times in water. Cheese, also, deprived of the salts, was given. Pigeons and mice took this food, in small morsels, for some time. Dogs also took it for a short time, but then refused it. Then they were compelled to take it. The mice lived from twenty-one to thirty days; the pigeons from thirteen to twenty-nine days; the dogs from twenty-six to thirty-six days.

Digestion went on regularly for the greater part of the time. The excreta, whether in quantity or in quality, were as usual. Consequently neither the process of digestion, nor the absorption of the materials digested, is influenced by the absence of salts from the food. In the case of a dog with a gastric fistula, fed on food deprived of the salts, direct evidence was obtained of the fact that the secretion of acids in the stomach goes on. After having been kept for a considerable period on this diet, the dog commenced to reject it from his stomach. What was thus rejected, though it had been in the stomach several hours, was not soured, nor had it the least unpleasant odor. It

looked like food that had suffered no change. It is, therefore, only at a late period in such dieting that the absence of the salts makes itself felt.

This was altogether unexpected; but the examination of the excreta, more especially of the urine, led to a conclusion of still greater moment. This urine contains traces only of the chloride of sodium, but little phosphoric acid, etc., although in amount the urine was the same as before the experiment. The residuum of meat which was given was not entirely deprived of its salts. There will always remain a small amount of phosphates. When, therefore, the organism is stinted in these salts, it daily parts with a small quantity of them through the excrement and the urine, but retains the greater part. The organs are tenacious of these salts. When we add salt to the food, it goes first into the blood, but it is not then immediately thrown off by the kidneys, etc. It is distributed through the system, and each one of the organs takes according to its wants. In the blood are also to be found the salts evolved in the destruction of the animal's substance, under the influence of abstinence. All these salts are then distributed, as we have already said, and thus that portion of them which is not thrown off serves again and again for the needs of the tissues. On this account their quantity varies but little in the system. We will not follow our author in his attempt to account theoretically for these phenomena, inasmuch as it belongs to the province of pure reasoning. We must be content to continue in the domain of experiment.

After a period of complete abstinence from salts, certain remarkable phenomena are to be observed in dogs. Though they may not decrease in weight, nor lose flesh or fat, they still become weak, dull, and lie down in a corner, languid and indifferent. On one occasion, even, as in the case of a dog of Dr. Bischoff's that was for a long time fed on bread alone, the animal apparently went mad. He fell into a rage, and ran round and round, heeding neither the voice nor the whip. The attack did not return, but the nervous system became more and more unstrung; paralytic symptoms were manifested in the hinder extremities; the animal's hind-legs failed him at every step, and he fell on his side: in the head were observable oscillatory movements, particularly when he ate or drank. On pushing the experiment still further, the animals invariably succumbed. If, however, instead of continuing the experiment, we give the dog the ordinary mixed food, he will commence gradually to recover his strength, and finally will be quite restored to health. During the period of recovery he will consume an unusual amount of food.

Thus is it demonstrated, in accordance with the views which Liebig was the first to maintain, that the salts are absolutely necessary. Without them the organism fails, even though it were to receive all the other elements. It will not, however, succumb instantaneously, but only after the lapse of a certain period of time. The salts differ

in many respects from organic substances. When the latter are decomposed, the residuum cannot be utilized by animals, and must consequently be evacuated. Not so with the salts, which, according to Voit, are not transformed. This view will not pass unchallenged, when we call to mind the later researches of W. Marcet with regard to the constitution of muscular tissue, wherein the English physiologist has found that the phosphates enter into the nutritive process in the colloid state, but quit it in the crystalloid state.

Klein and Verson, according to Prof. Voit, have claimed that common salt is not a nutritive salt, but a mere condiment, and that it may be altogether wanting in the body without inconvenience. These two gentlemen lived for eight days, consuming the while only 1.4 gramme of salt per day, without experiencing any indisposition. They, in fact, threw off, in the eight days, 46.9 grammes of chloride of sodium in the liquid and solid excreta; but we have to observe that they had been in the habit of consuming salt very freely (about 27 grammes per day). Still the common salt in the system was not exhausted.

Voit states, in a note, that in the case of dogs which have the normal supply of nitrogen, the addition of common salt to their food increases the amount of urine, as also the proportion of water in the same. Klein and Verson thought that, when they are deprived of this salt, the urine must decrease; whereas they found, on the contrary, that it increased. The salt only excites indirectly the increase of urine, by promoting the transformation of the albumen; and it may well be that, when the supply of salt is deficient, this transformation is similarly accelerated by other influences. Klein and Verson have not determined what are the necessary conditions for recognizing the action of any substance in this respect. We cannot tell whether or not the nitrogenous elements of the food, during their experiments, were a constant quantity, for they say "taking about 420 grammes of beef, etc." Nor could they say whether the nitrogen in their system was in normal quantity. But, aside from this, I do not find that an increased quantity of urine is by their figures shown to follow the privation of salt.

After reciting the facts which are ascertained with regard to the use of salt by domestic animals, the author adds that the constituent salts of the organs, of which we spoke above, are as necessary for the support of the organism as albumen, water, or the organic non-nitrogenous elements; but that, notwithstanding, no symptoms of scurvy or of disease in the bones is observable, even where animals are for a long period deprived of salt. He calls particular attention to this fact: Kemmerich, on one occasion, gave a dog during seventeen days the residuum of meat, with the salts of potash only, that is, the phosphate of potash and the chloride of potassium. He had deprived the food of its salts of soda. And yet the serum of the blood was found

to contain these soda-salts almost exclusively, while in the urine were found only the salts of potash. The salts of soda thus were altogether retained, as in the case where the salts were withheld.

It is not the functions of the nutritive salts that have been exaggerated hitherto, but rather the proportion in which they must enter into the food. They might be withheld for as many as forty days, for they are found in sufficient quantity in all substances which contain the other elements of nutrition. Haubner has stated that pigeons fed on grain, without lime, quickly die; but Voit has kept them on such food for a whole year. On food deprived of salts a pigeon can live for about thirty days.

When it is said that, without the nutritive salts, the residuum of meat, or any other kind of food, possesses no nutritive value whatsoever, the statement is true only in a certain sense, and as far as the duration of complete nutrition is concerned. Within a certain period of time, in the absence of the salts, the albuminates will cease to be assimilated, as also the fats and the hydrates of carbon. It is the salts that render the organic elements nutritive. The author hence concludes that none of these elements, whether organic or mineral, have any absolute nutritive value, and that they cannot be considered apart by themselves. They coöperate mutually in nutrition, and so are all equally indispensable to constitute proper food, such as may support life and strength. This is the most important datum of the numerous and varied physiological experiments made in Germany during the past few years, and it is a new discovery for us. Our physiologists and hygienists had no suspicion of such facts.

As we consume, with our food, considerably more of these salts than is needed to support the body, the question arises, Is this simply surplus, or are we benefited by it, as being a flavoring for the food? Much has been said about the *extractive* elements of meat, and it has been supposed that these elements form the true distinction between animal and vegetable food. According to this view they constitute the peculiar action of meat and of meat-extract. Here we must make a distinction between the nutritive element and the condiment.

The extractive elements of flesh-meat are the products of regressive change, and are not necessary for the constitution and formation of the organs; nor can they, when taken with food, add to the substance of those organs. The elements of this extract have been got in isolated forms, as creatine, sarkine, taurine, urea, uric acid, tyrosine, lactic acid, acetic acid, etc.; each organ has its own characteristic extractive principles, or its own products of decomposition, the conditions of this decomposition varying for the various organs.

# THE PHYSIOLOGY OF SLEEP.

By B. W. RICHARDSON, M.D., F.R.S.

"THE twinkling of oblivion," as Wordsworth exquisitely defines the phenomenon of sleep, has, from the time of Hippocrates to the present hour, engaged the attention of thoughtful minds. Poets have found in the phenomenon subject-matter for some of the most perfect of their works. Menander exalts sleep as the remedy for every disease that admits of cure; Shakespeare defines it, "The birth of each day's life, sore labor's bath;" Sir Philip Sidney designates it, "The poor man's wealth, the prisoner's release;" and wearied Dryden sings of it—

> "Of all the powers the best.
> Oh! peace of mind, repairer of decay,
> Whose balms renew the limbs to labors of the day."

As to the philosophers and the physicians who have said and written on sleep, I dare hardly think of them, lest I should commit myself to an historical volume instead of a short physiological essay; so I leave them, except such as are simply physiological, and proceed on my way.

Perfect sleep is the possession, as a rule, of childhood only. The healthy child, worn out with its day of active life, suddenly sinks to rest, sleeps its ten or twelve hours, and wakes, believing, feeling, that it has merely closed its eyes and opened them again; so deep is its twinkle of oblivion. The sleep in this case is the nearest of approaches to actual death, and at the same time presents a natural paradox, for it is the evidence of strongest life.

During this condition of perfect sleep, what are the physiological conditions of the sleeper? Firstly, all the senses are shut up, yet are they so lightly sealed that the communication of motion by sound, by mechanical vibration, by communication of painful impression, is sufficient to unseal the senses, to arouse the body, to renew all the proofs of existing active life. Secondly, during this period of natural sleep the most important changes of nutrition are in progress; the body is renovating, and, if young, is actually growing; if the body be properly covered, the animal heat is being conserved and laid up for expenditure during the waking hours that are to follow; the respiration is reduced, the inspirations being lessened in the proportion of six to seven as compared with the number made when the body is awake; the action of the heart is reduced; the voluntary muscles, relieved of all fatigue and with the extensors more relaxed than the flexors, are undergoing repair of structure and recruiting their excitability; and the voluntary nervous system, dead for the time to the external vibration, or as the

older men called it "stimulus" from without, is also undergoing rest and repair, so that when it comes again into work it may receive better the impressions it may have to gather up, and influence more effectively the muscles it may be called upon to animate, direct, control.

Thirdly, although in the organism during sleep there is suspension of muscular and nervous power, there is not universal suspension; a narrow, but at the same time safe, line of distinction separates the sleep of life from the sleep of death. The heart is a muscle, but it does not sleep, and the lungs are worked by muscles, and these do not sleep; and the viscera which triturate and digest food are moved by muscles, and these do not sleep; and the glands have an arrangement for the constant separation of fluids, and the glands do not sleep; and all these parts have certain nerves which do not sleep. These all rest, but they do not cease their functions. Why is it so?

The reason is, that the body is divided into two systems as regards motion. For every act of the body we have a system of organs under the influence of the will, the voluntary, and another system independent of the will, the involuntary. The muscles which propel the body, and are concerned in all acts we essay to perform, are voluntary; the muscles, such as the heart and the stomach, which we cannot control, are involuntary. Added to these are muscles which, though commonly acting involuntarily, are capable of being moved by the will: the muscles which move the lungs are of this order, for we can if we wish suspend their action for a short time or quicken it; these muscles we call semi-voluntary. In sleep, then, the voluntary muscles sleep, and the nervous organs which stimulate the voluntary muscles sleep; but the involuntary and the semi-voluntary muscles and their nerves merely rest: they do not veritably sleep.

This arrangement will be seen, at once, to be a necessity, for upon the involuntary acts the body relies for the continuance of life. In disease the voluntary muscles may be paralyzed, the brain may be paralyzed, but, if the involuntary organs retain their power, the animal is not dead. Sir Astley Cooper had under his care a man who had received an injury of the skull causing compression of the brain, and the man lay for weeks in a state of persistent unconsciousness and repose; practically he slept. He did not die, because the involuntary system remained true to its duty; and, when the great surgeon removed the compression from the brain of the man, the sleeper woke from his long trance and recovered. Dr. Wilson Philip had a young dog that had no brain, and the animal lay in profound insensibility for months, practically asleep; but the involuntary parts continued uninfluenced, and the animal lived and, under mechanical feeding, grew fat. Flourens had a brainless fowl that lived in the same condition. It neither saw nor heard, he says, nor smelled nor tasted nor felt; it lost even its instincts; for however long it was left to fast, it never voluntarily ate; it never shrunk when it was touched, and, when attacked by its fellows,

it made no attempt at self-defence, neither resisting nor escaping. In fine, it lost every trace of intelligence, for it neither willed, remembered, felt, nor judged: yet it swallowed food when the food was put into its mouth, and fattened. In these cases, as in that of the injured man, the involuntary systems sustained the animal life. It is the same in sleep.

FIG. 1.

Organic Nervous System which controls the Heart and the Organic Processes, and never sleeps.

When we look at these phenomena, as anatomists, we find a reason for them in structure and character of parts. The involuntary muscles have a special anatomical structure; and the nervous organism that keeps the involuntary muscles in action is a distinct organism. There are, briefly, two nervous systems: one locked up in the bony cavity of the skull and in the bony canal of the spine, with nerves issuing therefrom to the muscles; and another lying within the cavities of the body, with nerves issuing from it to supply all the involun-

tary muscles. The first of these systems, consisting of the brain, the spinal cord, and the nerves of sense, sensation, and motion, is called the cerebro-spinal or voluntary system of nerves; the second, consisting of a series of nervous ganglia with nerves which communicate with the involuntary muscles and with nerves of the voluntary kind, is called, after Harvey the vegetative, after Bichat the organic system: a sketch of this organic system is depicted in the accompanying diagram.

In sleep, the cerebro-spinal system sleeps; the organic system retains its activity. Thus in sleep the voluntary muscles and parts fail to receive their nervous stimulation; but the involuntary receive theirs still, and under it move in steady motion; while the semi-voluntary organs also receive sufficient stimulation to keep them in motion.

Of all the involuntary organs, the heart, which is the citadel of motion, is most protected. To itself belongs a special nervous centre, that which feeds it steadily with stimulus for motion; from the cervical ganglia of the organic nervous system it receives a second or supplementary supply; and from the brain it receives a third supply, which, passive under ordinary circumstances, can under extraordinary circumstances become active and exert a certain controlling power. Then the arteries which supply the heart with blood are the first vessels given off from the great feeding arterial trunk, and the veins of the heart winding independently round it empty their contents direct again into it. Thus is the heart the most perfect of independencies: thus during sleep and during wakefulness it works its own course, and, taking first care of itself in every particular, feeds the rest of the body afterward; thus, even when sleep passes into death, the heart in almost every case continues its action for some time after all the other parts of the organism are in absolute quiescence; thus, in hibernating animals, the heart continues in play during their long somnolence; and, thus, under the insensibility produced by the inhalation of narcotic gases and vapors, the heart sustains its function when every other part is temporarily dead. Next the heart in independent action is the muscle called the midriff or diaphragm; and, as the diaphragm is a muscle of inspiration, the respiratory function plays second to the circulatory, and the two great functions of life are, in sleep, faithfully performed. In sleep of illness bordering on sleep of death, how intently we watch for the merest trace of breath, and augur that, if but a feather be moved by it or a mirror dimmed by it, there is yet life!

In natural sleep, then, sleep perfect and deep, that half of our nature which is volitional is in the condition of inertia. To say, as Blumenbach has said, that in this state all intercourse between mind and body is suspended, is more perhaps than should be said, the precise limits and connections of mind and body being unknown. But certainly the brain and spinal cord, ceasing themselves to receive impressions, cease to communicate to the muscles they supply stimulus for motion, and the muscles under their control, with their nerves, therefore

sleep. And so, to the extent that the acts of the brain and cord and their nerves are mental, and the acts or motions of the voluntary muscles are bodily acts, to that extent, in sleep, the intercourse between the mind and the body is suspended.

In sleep the condition of the involuntary muscles and of the voluntary nervous system is, we must assume, in some manner modified, since these organs are transformed from the active into the passive state. Respecting the condition of the muscles in sleep, no study of a systematic sort has been carried out, but in relation to the brain there has been much thoughtful study, upon which many theories have been founded.

The older physiologists regarded sleep as due to the exhaustion of the nervous fluid; during sleep, they held, this fluid accumulates in the brain; and, when the brain and the other centres and nerves of the cerebro-spinal system are, to employ a common expression, recharged, the muscles are stimulated and the body awakes; the brain prepared to receive external impressions and to animate the muscles, and the muscles renovated and ready to be recalled into activity. This theory held its ground for many years, and, perhaps, still there are more believers in it than in any other. It fails to convince the skeptical because of its incompleteness, for it tells nothing about the nature of the presumed nervous fluid, and we know nothing as yet about this fluid. The primary step of the speculation is consequently itself purely hypothetical.

Another theory, that has been promulgated, is that sleep depends on the sinking or collapse of the laminæ of the cerebellum or little brain. This theory is based on the experiment that compression of the cerebellum induces sleep; but the argument is fallacious, because pressure on the larger brain, or cerebrum, is followed by the same result. The theory of pressure has been proposed again in a different way; it has been affirmed that the phenomenon of sleep is caused by the accumulation of fluids in the cavity of the cranium, and by pressure, resulting from this accumulation, on the brain as a whole. We know well that pressure upon the brain does lead to an insensible condition resembling sleep, and in some instances, in which the skull has been injured and an artificial opening through it to the brain has been formed, pressure upon the exposed surface has led to a comatose condition. I once myself saw a case of this nature. But the evidence against this explanation is strong, because the sleeping brain has been observed to be pale and too free of blood to convey any idea of pressure.

In opposition to the pressure theory, Blumenbach contended that sleep is due to a diminished flow and impulse of blood upon the brain, for he argued the phenomenon of sleep is induced by exhaustion, and particularly by exhaustion following upon direct loss of blood. Recently Mr. Arthur Durham, in a very able communication, has adduced a

similar view, and the general conclusion now is, that during sleep the brain is really supplied with less blood than in waking hours.

To account for the reason why the brain is less freely fed with blood in sleep, it has been surmised that the vessels, the arteries, which feed the brain, and which for contractile purposes are supplied with nerves from the organic nervous system, are, under their nervous influence, made to close so that a portion at least of the blood which enters through them is cut off on going to sleep. This view, however, presupposes that the organic nervous centres, instead of sharing in the exhaustion incident to labor, put forth increased power after fatigue, an idea incompatible with all we know of the natural functions.

Carmichael, an excellent physiologist, thought that sleep was brought on by a change in the assimilation of the brain, and by what he called the deposition of new matter in the organ, but he offered no evidence in proof: while Metcalfe, one of the most learned physicists and physicians of our time, maintained that the proximate cause of sleep is an expenditure of the substance and vital energy of the brain, nerves, and voluntary muscles, beyond what they receive when awake, and that the specific office of sleep is the restoration of what has been wasted by exercise: the most remarkable difference between exercise and sleep being, that during exercise the expenditure exceeds the income; whereas during sleep the income exceeds the expenditure. This idea of Metcalfe's expresses, probably, a broad truth, but it is too general to indicate the proximate cause of sleep, to explain which is the object of his proposition.

My own researches on the proximate cause of sleep—researches which of late years have been steadily pursued—lead me to the conclusion that none of the theories as yet offered account correctly for the natural phenomenon of sleep; although I must express that some of them are based on well-defined facts. It is perfectly true that exhaustion of the brain will induce phenomena so closely allied to the phenomena of natural sleep, that no one could tell the artificially-induced from the natural sleep; and it is equally true that pressure upon the brain will also lead to a state of sleep simulating the natural. For example, in a young animal, a pigeon, I can induce the deepest sleep by exposing the brain to the influence of extreme cold. I have had a bird sleeping calmly for ten hours under the local influence of cold. During this time the state of the brain is one of extreme bloodlessness, and, when the cold is cautiously withdrawn and the brain is allowed to refill gently with blood, the sleep passes away. This is clear enough, and the cold, it may be urged, produces contraction of the brain-substance and of the vessels, with diminution of blood, and with sleep as the result. But if, when the animal is awaking from this sleep induced by cold, I apply warmth, for the unsealing of the parts, a little too freely, if, that is to say, I restore the natural warmth too quickly, then the animal falls asleep again under an opposite condition; for now into

the relaxed vessels of the brain the heart injects blood so freely, that the vessels, in like manner as when the frozen hand is held near the fire, become engorged with blood, there is congestion, there is pressure, and there is sleep.

The same series of phenomena from opposite conditions can be induced by narcotic vapors. There is a fluid called chloride of aonyl, which, by inhalation, causes the deepest sleep; during the sleep so induced, the brain is as bloodless as if it were frozen. There is an ether called methylic, which, by inhalation, can be made to produce the deepest sleep; during this sleep the vessels of the brain are engorged with blood.

We are therefore correct in supposing that artificial sleep may be induced both by removal of blood from the brain, and by pressure of blood upon the brain; and in the facts there is, when we consider them, nothing extraordinary. In both conditions, the natural state of the brain is altered; it cannot, under either state, properly receive or transmit motion; so it is quiescent, it sleeps. The experimental proof of this can be performed on any part of the body where there are nerve-fibre and blood-vessel; if I freeze a portion of my skin, by ether-spray, I make it insensible to all impression—I make it sleep; if I place over a portion of skin a cupping-tube, and forcibly induce intense congestion of vessels, by exhausting the air of the tube, I make the part also insensible—I make it sleep.

The two most plausible theories of sleep—the plenum and the vacuum theories I had nearly called them—are, then, based on facts; but still I think them fallacious. The theory that natural sleep depends on pressure of the brain from blood is disproved by the observations that have been made of the brain during sleep, while the mechanism of the circulation through the brain furnishes no thought of this theory as being possibly correct. The theory that sleep is caused by withdrawal of blood from the brain, by contraction of its arterial vessels, is disproved by many considerations. It presupposes that at the time when the cerebro-spinal nervous system is most wearied the organic system is most active; and it assumes that the great volume of blood which circulates through the brain can be cut off without evidence of increased volume of blood and tension of vessel in other parts of the body, a supposition directly negatived by the actual experiment of cutting off the blood from the brain.

There is another potent objection applicable to both theories. When sleep is artificially induced, either by subjecting the brain to pressure of blood, or to exhaustion of blood, the sleep is of such a kind that the sleeper cannot be roused until the influence at work to produce the sleep is removed. But, in natural sleep, the sleeper can always be roused by motion or vibration. We call to a person supposed to be sleeping naturally, or we shake him, and if we cannot rouse him we know there is danger; but how could these simple acts remove

pressure from the brain, or relax the contracted vessels feeding the brain?

These two theories set aside, the others I have named need not trouble us; they are mere generalizations, interesting to read, worthless to pursue. Know we then nothing leading toward a solution of the question of the proximate cause of sleep? I cannot say that, for I think we see our way to something which will unravel the phenomenon; but we must work slowly and patiently, and as men assured that, in the problem we are endeavoring to solve, we are dealing with a subject of more than ordinary importance. I will try to point out the direction of research.

I find that to induce sleep it is not necessary to produce extreme changes of brain-matter. In applying cold, for example, it is not necessary to make the brain-substance solid in order to induce stupor, but simply to bring down its temperature ten or twelve degrees. I find also that very slight direct vibrations, concussions, will induce stupor; and I find that, in animals of different kinds, the profoundness of sleep is greater in proportion as the size of the brain is larger. From these and other facts, I infer that the phenomenon of natural sleep is due to a molecular change in the nervous structure itself of the cerebro-spinal system, and that in *perfect* sleep the whole of the nervous structure is involved in the change—the brain, the cord, the nerves; while in imperfect sleep only parts of this nervous matter are influenced. This is in accord with facts, for I can by cold put to sleep special parts of the nervous mass without putting other parts to sleep. In bad sleep we have the representation of the same thing in the restlessness of the muscles, the half-conscious wakings, the dreams.

Suppose this idea of the change of nervous matter to be true, is there any clew to the nature of the change itself? I think there is. The change is one very closely resembling that which occurs in the solidification of water surcharged with a saline substance, or in water holding a hydrated colloid, like dialyzed silica, in trembling suspension. What is, indeed, the brain and nervous matter? It is a mass of water made sufficiently solid to be reduced into shape and form, by rather less than twenty per cent. of solid matter, consisting of albuminous substance, saline substance, fatty substance. The mechanism for the supply of blood is most delicate, membranous; the mechanism for dialysis or separation of crystalloidal from colloidal substance is perfect, and the conversion of the compound substance of brain from one condition of matter to another is, if we may judge from some changes of water charged with colloidal or fatty substances, extremely simple. I do not now venture on details respecting this peculiarly interesting question, but I venture so far as to express what I feel will one day be the accepted fact, that the matter of the wakeful brain is, on going to sleep, changed, temporarily, into a state of greater solidity; that its molecular parts cease to be moved by external ordinary

influences, by chemical influences; that they, in turn, cease to communicate impressions, or, in other words, to stimulate the voluntary muscles; and that then there is sleep which lasts until there is re-solution of structure, whereupon there is wakefulness, from renewed motion in brain-matter, and renewed stimulation of voluntary muscle, through nerve.

The change of structure of the brain which I assume to be the proximate cause of sleep is possibly the same change as occurs in a more extreme degree when the brain and its subordinate parts actually die. The effects of a concussion of the brain from a blow, the effects of a simple puncture of nervous matter in centres essential to life—as the point in the medulla oblongata which Flourens has designated the vital point—have never been explained, and admit, I imagine, of no explanation except the change of structure I have now ventured to suggest.

Here, for the moment, my task must end. My object has been to make the reader conversant with what has been said by philosophers upon the subject of sleep and its proximate cause, and to indicate briefly a new line of scientific inquiry. I shall hope on some future occasion to be able to announce further and more fruitful labor.

## CHARACTERISTICS OF THE CALMUCKS.

AN ETHNOLOGICAL STUDY.

By J. KOPERNICKI.

THE Calmucks primitively inhabited the countries northeast of the Chinese Empire. At the commencement of the seventeenth century, they arrived on the shores of the Caspian Sea; and they have camped there to the present day.

The first glance at a Calmuck suffices to recognize in him the model representative of the true Mongol type. They are of middle stature, robust, and broad in the shoulders. Their skin is swarthy, face flat, fissure of the eyelids narrow and oblique, nose depressed, nostrils wide, lips thick, teeth white and regular, ears long and prominent, hair black, and beard thin.

The principal trait in the character of the Calmucks, after their simplicity, want of cleanliness, and laziness, is that, after the manner of all nomad people, they are extremely superstitious. The Calmuck never undertakes any serious matter without having previously consulted a sorcerer. He never dares to kill a fly, for fear of assailing the soul of one of his ancestors, which may perhaps animate this insect. When, on a journey, a Calmuck perceives a certain bird which he esteems

to be a good augury, he rejoices in this conjuncture, does not fail to manifest his satisfaction, and bows himself three times. As soon as he perceives a hare, on the contrary, he utters a cry, pursues it, and strikes a blow in the air with his stick, in order to exorcise the misfortune which might happen. For the world, he would not pick up a steel for striking a light found upon the way. To seat himself upon the threshold of the door, or warm his feet before the fire, he holds for a great impiety; and if it happens to any one to light his pipe with paper, it is certain that he will soon die.

Notwithstanding these superstitions of the Calmucks, they are said to possess a good deal of intelligence. Their imagination, especially, is much developed, and they are ingenious, as is proved by their tales and proverbs. Some of their tales are so long that they require many evenings to be recited to the end. The Calmucks recite them in a singing tone.

Being exclusively occupied in raising cattle, the life of the Calmuck is nomad. A *khoton*, which is a commune, more or less numerous, composed of many families united by bonds of relationship, never remains more than two or three weeks in the same place. Transmigration from one place to another is a real feast to the Calmucks. All their goods, including their tent, are loaded upon the back of a camel, and covered over with a piece of drapery if the family is in easy circumstances. The women and girls, in holiday dress, as well as the young boys, drive the flocks. The little infants are placed in panniers, which are attached to the sides of the loaded camels, and the mother who is suckling is mounted on the top with her infant. The men on horseback take the lead, and conduct the caravan. The march, which sometimes lasts many days, does not tire the Calmucks; and they often divert themselves with songs and stories.

Behold them at last arrived at a spot which affords more abundant pasturage. They make a halt, unload the camels, and set to work to erect the tents, which does not require much time. At the end of half an hour, the framework of the tent is put up. It has the form of a truncated tunnel reversed, resting by its base upon a cylindrical support, which has the same circumference. It is covered outside by a felt cloth, and inside with reed mats. At one side there is an opening, into which is fitted a wooden frame for the door. This door, being open all day, allows the air and light to enter into the interior of the tent, which also receives a little light from above by an opening in the centre of the roof. The floor is covered with a carpet and felts in summer, and with the skins of different animals in winter. The arrangement of the interior does not require much pains or time. Opposite the door they put up against the side of the tent a low couch. On the left of this is raised the grand *baran*, the most sacred place in the habitation of a Calmuck. It is upon this that the objects of his religious adoration are deposited, as well as all the treasures of his

family. Upon the spot in which this great baran is to be raised, they first spread the coverings and caparisons of the horse-equipage and saddles; upon these are placed coffers with clothes: these being covered over with a drapery, they deposit last of all the trunks in which are kept the Calmuck's idols. These being withdrawn from the trunks and placed upon the draperies, a sort of altar is raised. It is a little wooden table, upon which they arrange many little dishes of silver and copper, intended to receive offerings, cheese, gruel, and different kinds of incense. Lastly, before this little table they plant in the soil a piece of wood surmounted with a small silver cup. It is in this that the head of the family deposits the first morsel of every dish that is eaten during the common repast.

Fig. 1.

Feodor Ivanovitsch, a Calmuck Painter of some Celebrity at Rome.

The entire arrangement of the tent, both outside and inside, is the affair of the woman. The husband only charges himself with the construction of the framework, and with some definite corrections which may be necessary. He passes his time in the chase, in pasturing his flocks, or simply doing nothing. All the charge and cares of the household belong to the woman.

In the family life of the Calmucks, the marriage of a son or daughter is a principal occasion of rejoicing and of feasts. The choice among the Calmucks belongs entirely to the parents. Still, there is no con-

straint upon this point, and, if the son declares that the selection of his parents displeases him, there is no further question about the matter. In considering marriage as the most serious and grave act of life, the Calmucks never undertake it without the benediction of their priest. As soon as he, after having consulted the constellations under which the affianced were born, declares that there are no obstacles to their marriage, one of the elder relatives, on the part of the boy, repairs to the parents of the girl, and, after having regaled them with *eau-de-vie*, announces the object of his visit. It is rare that a refusal takes place in these cases. The parents, having given their consent, may expect the formal demand in marriage. Some days afterward, the father of the affianced youth, having taken with him a provision of wine, a sheep, a block of tea in the form of a brick, and a roll of paper containing a strap and a piece of fish-glue, accompanied with many friends, who ought to be absolutely married, repairs to the khoton of the betrothed girl. Having arrived in the tent, he begins by serving out the wine to all present; then he brings up the sheep, which his friends kill, and immediately put it into the caldron to be boiled. The little packet, containing the tea, the strap, and the glue, is presented to the father of the affianced girl. The tea is consumed at once, and the two other objects, which represent the jewels of betrothal, are deposited on the little table before the idols.

The demand in marriage is shortly followed by betrothal, which consists in the youth repairing to the khoton of his intended bride, and offering her presents of dresses and stuffs. This, which takes place without any thing in particular being said, gives occasion to a fresh banquet. Between the betrothal and the marriage, there sometimes elapses a whole year, or even more. During this long interval, sometimes the youth, sometimes his parents, come from time to time to see the affianced. When she has completed her sixteenth year, the parents of the youth address the priest, beseeching him to fix the propitious and happy month and the day for the celebration of the marriage. Afterward, some days before the date fixed, the whole family of the young man go to the tent of the betrothed. The first day of their arrival passes in doing the honors of reception; the next day the parents of the youth declare to those of the affianced girl their desire that the ceremonies of the marriage should be accomplished, and at the same time they endeavor to learn, in an indirect manner, to what sum the expenses on the part of the young man would amount, and what feasts ought to be offered to the most notable guests, to the acquaintances and the parents of the girl. They never speak of dowry, since the woman ordinarily receives every thing necessary for housekeeping.

The day of the marriage, the young man, with his assistants, well provided with wine and viands, repairs to his future father-in-law's, where they make a great feast. When the feast is concluded, he is

invited into the tent of his betrothed, where is exposed her entire dowry, which they shortly send to his khoton. Sometimes the entrance is guarded by the companions of the betrothed, armed with sticks, so that the youth often has great difficulty in gaining an entrance. In order to avoid the blows which threaten him, he offers sweetmeats to the guard. When this guard is satisfied, the young man carries away his betrothed, places her behind him upon his saddle, and repairs to the khoton of his parents.

Here there has been early prepared a tent to receive the newly-married people, and it is before this that the following marriage ceremony is performed: Before the entrance they spread a carpet, and upon this is put a quilt of white felt. Behind the carpet is found the table with the idols, before which is placed, in an offering-dish, a shoulder of mutton, as an emblem of riches. The affianced, surrounded with acquaintances and relatives, place themselves before the sacred table; the priest recites many prayers, after which he seats himself upon the carpet, takes the fold which veils the face of the girl, envelops in it the shoulder of mutton, and presents it to her. The young man takes it in his left hand and his betrothed in the right. Then the priest, after having pronounced many more prayers, raises the two affianced up, and recommends them to bow three times to the earth. They execute these motions without relinquishing the shoulder of mutton, which they continue to hold in their hands, and, in making each reverence, they pronounce the following words:

"I incline myself this first time to adore my Lord God, who is my father and my mother.

"I incline myself this second time to adore my Sun, which is the light of my beloved day; and my Moon, which is the light of my beloved night.

"We swear to love one another, to respect one another mutually, and to partake in common of all the trials and all the joys of our life."

After which, the priest having taken an idol from the table and touched the heads of the couple, the principal and essential portion of the ceremony is finished.

The rest is accomplished in the interior of the tent. Having entered, the affianced incline themselves three times before the idols, and seat themselves in their places, the youth on the bolster of the bed, and his affianced at the other end. After which, all the acquaintances enter and occupy their places. The priest takes the shoulder of mutton, cuts the flesh in pieces, and distributes them to the betrothed and their parents: the viand is consumed instantly; and the bone is preserved as a sacred thing, as a pledge of the future happiness of the new family.

Having accomplished all this, the priest retires, and the party devote themselves to the rejoicings they have been so long expecting, which are prolonged two or three days. Among these entertainments

during the marriage-feast, an indispensable part is assigned to wrestling, which is an exercise much esteemed among the Calmucks.

The marriage ceremonies among notable Calmucks are conducted rather differently; yet the difference only consists in this: Ordinarily, it is not the youth in person, but one of his nearest relations, who is charged with conducting his betrothed. The young man meets her on the way, and it is at this place that the principal ceremony of the marriage is accomplished. Arrived at the tent of her husband, the girl does not descend from the horse until she is taken off in his arms. Afterward her horse is set free, and passes into the possession of him who first catches it.

In that which concerns the position of the woman in the Calmuck family, it is much superior in comparison with that which occurs among other people who are on the same level of civilization as the Calmucks. The law, consecrated by usage, in making the Calmuck woman full mistress of the household, determines strictly what ought to be the conduct of the man. The man has not only no right to raise his hand against a woman, but he is obliged, on the contrary, to treat her with respect. Thus, for example, in inviting a woman to dance, he ought to kneel, and carry his hand to his forehead, and afterward to the knee of his wife. She, on the other hand, in inviting one to dance, has only to incline herself gently, and to touch his shoulder. A man is not permitted to refuse a dish or a drink which is offered to him by a woman. Also, upon a journey, if he perceives that a woman intends to descend from her horse, he is expected to get off immediately to assist her to descend.

Such are the laws and usages of the Calmucks with respect to their women; but, at the same time, these laws are not observed very strictly. The Calmuck treats his wife with consideration only in the presence of other persons. When alone, it often happens that he beats her, not only for some omission or negligence on her part, but, for example, for having carelessly trodden upon the foot, the gun, or the stick of her husband.

Divorce is equally forbidden by law, but usage gives the husband the right to send his wife back as soon as she displeases him, and that without assuring her the means of subsistence. In case a Calmuck abandons his wife in an honorable manner, he gives an especial entertainment, to which all her relations are invited. When the repast is ended, he orders a horse out, ready saddled, to carry back his wife to the khoton of her parents.

Besides the cares of the household, the Calmuck woman is charged with the education of her children. The birth of a child among the Calmucks does not give occasion to any particular ceremonies. Scarcely has the new-born child come into the world, when it is carried out of the tent, and the first object which then presents itself to the eyes—dog, sheep, serpent, or other—yields its name to the infant. Some-

times the priest is invited to give it the name which he finds in his book. Besides which, each Calmuck bears a certain *sobriquet;* for example, *badma*, flower, *narbo*, jewel, etc.

The Calmucks do not reckon their age from the time of their birth, but by a peculiar calculation. Thus, the day of the new year (November 24th—December 6th) being the *general birthday*, they reckon that a child born, if only a few days before that day of the year, is two years old. The Calmucks trouble themselves very little with the education of their children. As soon as a child begins to walk, he is abandoned to himself, and he habituates himself gradually, by his own experience, to all the privations of a Calmuck existence. When arrived at the age of eight years, the boy is sent to some priest to commence his studies. These consist in learning to read and write and endure for two or three years. The master is paid by means of presents received from the parents at the commencement and at the termination of the course. The girls of the Calmucks, as well of the poor as of the rich, do not learn to read or to write. A girl having finished her thirteenth, and the boy his fifteenth year, they convoke the near relatives, and invite the priests. After a short prayer before the idols, the boy or girl having attained majority is introduced, and his or her hair clipped on the temples. From this moment they are considered marriageable, and they shortly become betrothed.

The *religion* of the Calmucks is Lamaic, or Buddhist. The doctrine of Buddha, undergoing corruption among the Calmucks from generation to generation, consists at the present day of a most absurd mixture of credences.

According to their ideas, before the creation of the universe, there existed an enormous abyss, which was 20,000,000 miles in depth, and 60,000,000 in breadth. From the bottom of this abyss there came out golden clouds, which afterward condensed into a cloud charged with lightning, and then melted into abundant rain, which formed the ocean. This ocean was nearly 6,000,000 miles in length and 7,000,000 in breadth. In time the winds gradually formed a great quantity of froth on the surface of the ocean, and of this froth the continent was formed. In the first place, there appeared the mountain Summer, which is more than 200,000 miles in height. Upon the top of this gigantic mountain, of which we only see the half, is found a vast plain. The mountain itself has the form of a rock with four flanks. Each side of the mountain has a different color: silvered on the side of the east, red on the west, blue on the side of the south, and golden on that of the north. Around the Summer are found four great islands, which form the four parts of the world. The isle of the south is that which we inhabit; that of the east is peopled with men who live 150 years; the isle of the west, which abounds with cattle, is inhabited by giants; lastly, the isle of the north is peopled by peculiar beings—they each live 1,000 years, and the end of their lives is announced to them by an unknown voice.

The first inhabitants of this world were divine beings. They primarily inhabited the seventh heaven, but at one time they lapsed into war one against the other. The good conquered; and the wicked were forced to quit heaven, and they installed themselves upon the summit of Summer. Nevertheless, the contest begun in heaven always continued, and the number of fugitives increased so that they occupied all the islands which surrounded the mountain Summer. At the commencement of their terrestrial life, they preserved their divine qualities. Thus, for instance, they each lived 80,000 years, their faces were luminous, they possessed wings wherewith to fly, they went without food, etc. But one day there appeared upon the earth a certain fruit named *shime*, which was as sweet and as white as sugar. As soon as men tasted it, they lost all their qualities of perfection; the brilliancy of their faces disappeared, their wings fell off, they felt the need of nourishment, and the duration of their lives sank to 10,000 years only.

As long as men had luminous faces, there was no reason or necessity for the existence of the sun and moon. But, as soon as the shining of their faces was extinguished, obscurity spread over all the earth. Then four benevolent persons having taken pity on the human race, and having seized the Mount Summer in their arms, shook it so violently that the ocean of the universe was agitated, in consequence of which there appeared the sun, the moon, and the stars.

The sun, according to the doctrine of the Buddhists, is a globe of crystal, being more than 700 miles in circumference. In its interior there is lodged a luminous being, whose radiant face spreads light and heat over all the earth. The sun is placed in an enormous plain, all covered with the most splendid flowers. Every twenty-four hours seven aërial horses draw it round Mount Summer. In the morning the rays of the sun fall upon the silver side of Summer, before noon upon the blue side, at noon upon the golden side, and lastly, in the evening, its red side is illumined. Afterward the sun hides himself entirely behind the mountain, in consequence of which darkness and night ensue.

The moon, according to the ideas of the Buddhists, is also a globe of crystal, but filled with water, and it also is inhabited by a luminous being. The phases of the moon depend on its more or less remoteness from the sun; and the spots which are perceived on its surface are the shadows of the different marine animals which live in the universal ocean. After having created the sun and the moon, the creative gods held a council, during which the wicked spirit glided in unperceived and drank up all the sacred water of the vase which stood before the gods. Indignant at this audacity, they decided to punish him, but for a long time they could not discover where he was. They then interrogated the sun, and the sun gave them an unsatisfactory reply. They then addressed themselves to the moon, and she indicated to them the place in which he was hidden. In revenge for this

he had frequent quarrels both with the sun and the moon, and sometimes he fought with them. During these duels there was an eclipse upon the earth.

The stars, likewise, are equally great globes of crystal, inhabited by spirits. One only among all the stars—the pole-star, called the "pile of gold"—is fixed. All the others, to the number of 225,000,000, are transposed by aërial horses from one place to another. The fall of a star signifies the death of its inhabiting spirit, whose soul then descends into the abyss to animate another body.

The change of seasons is produced by a winged dragon. During the whole of winter it is in repose, lying upon the seven seas. In summer it rises up with the vapors, and ascends toward the upper strata of the atmosphere. The creature which rides this dragon excites it from time to time to thunder and to vomit flames. From time to time also he shoots from heaven fiery and deadly arrows.

As to the past destinies of the human race, the Buddhists teach thus. Men, having tasted the fruit shime, could not any longer do without nutriment; and, since the shime could not suffice for them all, they began to feed upon terrestrial honey and some vegetables. The fear of the want of food has forced every one to think only of himself, and to seek to provide for the future. Indigent people began to envy those who were richer. The discord which arose among men forced them to choose chiefs charged with their well-being. These chiefs abused the confidence placed in them, and, supporting themselves upon their power, changed into despots.

In proportion as iniquities multiplied among men, their longevity decreased more and more, and at length arrived at its present degree. During this period of continual calamities, many deities, clothed in human form, descended from time to time upon the earth, and preached penitence and correction. There were four of them; and the last is recognized as the founder of Buddhism. He taught his doctrine to sixty nations, each one of which understood it differently, which has occasioned the origin of so many different religions that prevail upon the earth.

As to what concerns the future destinies of the human race, they teach that the stature and the age of men will sink by degrees, and that there will come a time at which human stature will not exceed twenty-eight inches and a half. Then each child will speak immediately after its birth, and the next day it will be capable of undertaking its own management. They will marry at five years of age, and will not live longer than ten years. The human race having arrived at such a state will be the sign that the moment of universal destruction is at hand. Seven years before this cataclysm, the earth will become completely sterile, and the greater part of mankind will die. Afterward a great number of swords will be cast down from heaven, which will put to death the rest of the survivors, excepting a single

just family, which will be hidden in a ravine. After which the earth will be covered with dead bodies and gorged with blood. It will rain a purifying rain, afterward a fecundating rain; lastly, a third rain will bring all that is indispensable to man. The family which was hidden will then come out from its refuge, and many other virtuous men will be resuscitated to recommence their new life, which will endure 80,000 years, and to enjoy all the blessings of the earth.

But shortly men, forgetting past misfortunes, will begin again to do evil, and consequently their longevity will be gradually decreased. When human life will not endure more than 2,000 years, there will appear upon the earth the being Maïdari. He will be of high stature, and of dazzling beauty. Men, surprised with his exterior, will ask him by what means he had arrived at such perfection. To which Maïdari will reply that all this came to him in consequence of his good works, by which they also are capable of gaining the same perfection. The example and the instruction of God reacting upon men, they will be corrected, and they will live anew 80,000 years. This second change will be followed by fifty-four new ones; and each eighth change will be accompanied by a deluge, all the others by a fire.

The Buddhist doctrines of the soul, of punishments and rewards which are prepared for every one after death, are equally very strange. The souls of all creatures pass after death into new beings. Each soul prepares itself for this transmigration during its terrestrial life. Dwelling in the human body, the soul never seats itself in one single definite place, but every day changes its seat. Thus, on the first of each month the soul finds itself in the forefinger; the second day it resides in the foot; the third day in the calf of the leg; the fourth in the knee. In this way it ascends every day higher; at the eighth day it finds itself in the loins; the twelfth it passes into the palm of the hand; the fifteenth it spreads through the whole body; the sixteenth it seats itself in the nose; and on the last day of the month it appears in the thumb. Afterward its migration recommences in the same order. The injury of a part, when the soul is seated in it, is always followed by an inevitable death. After death the soul passes into one of the six reigns, and animates some other body.

The choice of a reign does not depend upon the soul itself, but it is fixed by the judge of the lower regions, who takes into consideration the good works accomplished upon earth. The habitation of the judge of the infernal regions is situated in a subterranean palace, surrounded with sixteen walls of iron. It is there that all the souls of dead men present themselves before him, except those of lamas, which ascend at once toward the happier dwelling-place. Each soul is escorted by two spirits, the good and the wicked, who, presenting it to Erlik-Khan, place before him white and black stones. If the white stones, which signify good works, exceed the black, then the soul, placed upon a gold-

en throne, ascends to the kingdom of the good. In a contrary case, it descends to be purified in another kingdom, which is divided into thirty-six sections. The inhabitants of this kingdom remain there five hundred years at least, and every day of these years is equal to one of our months. The souls here undergo pains more or less severe, according to the nature and the degree of their crimes. Thus, cruel chiefs and homicides are condemned to swim without rest in a sea of blood; misers, transfigured into monsters, having a mouth as small as the eye of a needle and a throat as fine as a thread, have nothing but flames upon which to feed and blood to drink. These poor damned continually rove over a desert plain, seeking in vain some nourishment. They sometimes perceive trees full of delicious fruits, but scarcely do they happen to approach them than the trees disappear, and the unfortunates behold themselves again abandoned to their punishment in the midst of the desert.

The punishments practised in the kingdom of eternal pains are still more terrible. Situated at 200,000 miles below the earth, it is divided into sixteen sections. In the first, the damned, half dead, are continually cast from knives to knives; and this punishment endures for 500 years, of which each day further equals 9,000,000 years. In the second section, the condemned are continually sawn. In the third, they break them in an iron press, and every time they revive they are bruised again. In the fourth and fifth sections, the condemned are roasted by the fire. In the sixth, they are boiled. In the following, they are frozen to the degree that their skin is covered with blisters, their lips split into shreds, etc. Not only men, but animals also, are condemned to undergo different pains. Thus, some are condemned to bear different burdens; others to run without rest, and to be torn in pieces by ferocious animals.

Just as the punishments of hell are terrible, so also the enjoyments of paradise, prepared for the just, are delicious. The paradise of the Buddhists is divided into five regions, each of which bears the name of one of the principal idols. The first kingdom is full of trees of silver, with branches of gold, which bear, in the place of fruit, stones the most precious. Streams of living water irrigate this miraculous country, in the midst of which is found a delightful forest, in which the spirit, surrounded by the just, reposes upon a throne, which is supported by a peacock and a lion.

The chiefs of the Buddhist clergy are the *Dalai-Lama* and the *Bogdobatsin*. They both reside in Thibet. Formerly Dalai-Lama exercised the civil and spiritual power in the whole of Thibet. But since 1703, that is, since that country has passed under the power of China, Dalai-Lama has not only lost his civil power, but he has been obliged to divide with Bogdobatsin his spiritual power also. Notwithstanding, Dalai-Lama always exercises an enormous authority. He inhabits the palace which is constructed of stones proceeding from a sacred

mountain of Thibet, and contains 999 chambers. At a mile from this palace stands the celebrated temple Dshu. Every new year there assembles in this temple the clergy of the whole of Thibet, to the number of 17,000 men. They celebrate there day and night divine service for twenty-one days.

All the rest of the clergy is composed of lamas. To become a lama is not an easy thing. For this, besides the three principal books, it is necessary to read a multitude of others, which embrace many hundred volumes. It is also necessary to be instructed in astronomy, in medicine, and in other sciences; and lastly, which is the most difficult, it is necessary to perform the *vote* to think upon God every moment, and strictly to execute all the commandments, the number of which surpasses two hundred.

The social organization of the Calmucks at the commencement of the seventeenth century, that is to say, at the epoch of their arrival in Russia, was purely patriarchal. Many families united by the bonds of relationship formed a khoton, of which the most aged was the head. Many khotons composed an *aïmak*, governed by the *zaïsangh* the power of whom was hereditary from father to son. Afterward many aïmaks in their turn formed a commune, and many communes composed an *oulouss*, governed by a *nohyon*, or chief. Lastly, a certain number of oulouss, united under the command of a *taïsha*, formed a tribe. The taïsha, who had the rank of a prince, governed personally in the principal oulouss; and all the others he ceded to his sons and brothers, who governed there by turns. All the tribes united constituted the entire people, commanded by the *khan*.

The actual rule over the Calmucks belongs to the *Court of Domains*, at Astrakhan. Formerly there were three kinds of punishment —corporal punishment, fine, and the degradation of the criminal in the face of the entire tribe. Thus, for example, for disobedience to parents, as well as for rudeness or insolence to elders or chiefs, they applied to the offender, first, a certain number of blows with a stick, and then, after having daubed his face with soot, and tied a pan round his neck, they promenaded him through the whole khoton. This chastisement is called *degradation by means of the hand*, because, to apply it, he who is charged with its execution takes a handful of soot from the bottom of the pan, and spreads the whole handful over the face of the offender. For a theft they punished the thief by promenading him equally through the khoton by a cord round his neck. Those who met him gave him blows with a rod on his naked body, and some deride him.

The exercise of justice has three degrees: The first, which was practised in the khoton, had a family character. The second consisted in a veritable tribunal, named *zargo*, and was composed of the zaïsanghs under the presidency of a nohyon. Lastly, the supreme tribunal, after the number of its members, called *Judgment of the*

*Eight*, was composed of the nohyons, under the presidency of the Khan. In this supreme tribunal were judged all criminal affairs of every nature. Murder was considered as the gravest of crimes. In the eyes of the Calmucks it was a frightful sin, and absolutely unpardonable. For murder committed for the first time, the offender paid a fine, judicially decreed to the parents of the person killed, in the manner of a retribution. Besides which, he was obliged to renounce every kind of enjoyment during a certain time, to carry a red scarf round his shoulders, and to do penance during some time near a temple. For a second murder, the fine and the penitence were heavier, and, further, the criminal was marked on the face. Lastly, he who had committed a homicide for the third time was marked on both sides of the face, and expelled forever from the midst of the people. In case the condemned had not the means of paying the fine, he was surrendered in person to the disposal of the relations of his victim, who had the full power to employ him in any kind of labor, as well as to sell him, or to exchange him for a flock of sheep.

In the case in which there was no confession on the part of the accused, or of failure of sufficient proof to establish the crime, the tribunal had recourse to *the oath of justification*. To accomplish this appeal, the accused might choose an adversary, who was generally reckoned an honest man. For the accomplishment of this act, they prepared a tent, in which, upon an elevation, an idol was exposed, before which they lit a perfumed taper. On the two sides of the idol they raised the images of punishing beings, under which were arranged the priests with their musical instruments, employed in divine service. Upon the floor of the tent they spread the skin of a cow, quite black, recently skinned, and moistened with the blood of the immolated beast. Above, and to the right of the door, inside the tent, they suspended the head of the same cow. Its eyes were opened wide, the tongue drawn out and turned to one side. On the left of the door they suspended a human skull, and below this last they placed a loaded gun with its lock tied up. Outside the tent, on the two sides of the door, were placed the judges, the accusers, and the accused.

All these preparations being made, the person chosen by the accused for an adversary was first obliged to persuade the parties to be reconciled, in order to avoid the necessity of so great and solemn an oath. If this exhortation had no success, then they proceeded to accomplish the *shakhan*, which took place in the following manner: The accused who has to swear, being undressed to his shirt, placing himself upon the bloody skin of the cow, after making three profound bows, ought to jump over the threshold of the tent. Scarcely has he made the first movement to advance, than the priests begin to sound their trumpets, little bells, and metallic plates, to blow into shells, etc. These solemn sounds accompany the oath at the table upon which the idol rests, and this music is only interrupted by the slow recitation of

prayers. Naturally, all this ceremony must react strongly upon the imagination of the accused; but when the accusation is unjust he is not in the least confused, and comes without fear to the idol; he extinguishes the lighted taper before the idol, after which, inclining himself toward the table, he seizes the heart of the cow with his teeth, which was exposed there upon a dish, and carries it out of the tent. Here one of the priests receives this revealing object from him, and passes it to the judges to be inspected. If, on inspection, there are no injuries observed upon the heart, then the accused is acquitted, and the accuser is condemned to a fine fixed upon beforehand.

All this mysterious ceremony would impress the Calmucks deeply by its solemnity, and inspire them with sentiments of terror. And this so much the more easily, as each detail of this shakhan had a certain symbolical signification. Thus, the black cow was the symbol of death, which ought to recall to the person taking the oath the enormous responsibility to which he exposed himself, if he had taken a false oath. The charged gun, with the lock bound up, signified that the perjured ran the risk of being immediately struck by divine justice. And the head of the cow, monstrously disfigured, ought to recall to him that his soul would be excommunicated from the midst of men, and driven into some frightful and monstrous being. The idol spoke to him of the presence of the supreme judge, who listened to his oath. The illuminated taper signified the divine light spread abroad by the Creator, and its perfume signified the grace of God, both of which the perjured renounced and deprived himself of voluntarily in extinguishing the taper. Lastly, the heart of the immolated cow signified the innocence of the person swearing, and the purity of his intentions.

Of all this terrible oath there remains at the present day but a very small portion in use. In doubtful and very grave cases, the Calmuck, who has to justify himself by means of the oath, only approaches to the table of the idol, before which he prostrates himself three times to the earth, and, after pronouncing with a loud voice, "I am innocent!" he extinguishes the taper, to express that he renounces the favors of the Creator if he has lied. Such an oath is very serious, and appears to be the only relic which testifies to the ancient *régime* proper to the Calmucks. At the present day their ancient judgment, as well as the punishments of former times, is abolished, and the Calmucks are judged according to the common laws of the empire.

As to their actual chiefs, these have preserved to the present day the same authority in the eyes of the Calmucks which they formerly possessed. A chief is respected not only by his subordinates, but by all the other Calmucks. They dare not enter into his tent without having first made a sign of reverence, which consists in him who is entering touching with the palm of his hand the door of entrance, and afterward his own forehead. In withdrawing from the tent they march

backward, in order not to turn the back upon the chief. If he permits his subordinate to sit in his presence, this person thanks him by carrying his hand to his forehead; afterward he places himself upon his knees, and, resting his two hands there, seats himself lastly upon the soles of his feet.

The clergy enjoy among the Calmucks a respect equal, if not superior, to that which they manifest to their chiefs. The supreme chief of their clergy is a lama. Up to the year 1800 he was always instituted by the Dalai-Lama of Thibet, but now it is the Russian Government which names him. The fixed residence of the lama is at the distance of a league from Astrakhan, at Bazar Kalmouke, by the shore of the Volga. Every summer the lama quits his residence to make the tour of the steppes.

All the priests are exempt from taxes, and subsist upon offerings, which consist of cattle, different objects, and money. They exercise medicine among the Calmucks, and, notwithstanding their ignorance in this science, they nevertheless enjoy a much greater confidence among the population than any physician appointed by government.

A priest being called to a sick person, begins by giving him soup to drink, pure water, or he prepares the most ordinary medicaments for him; and for nothing but this he frequently deprives the poor Calmuck of all that he has, under the pretext of the offerings demanded for the idols, the intervention of which is indispensable to procure the cure of the sick. If it is a rich man who becomes ill, then there are many who take charge of his treatment. They do not fail to take away all that their client possesses—his treasures, flocks, and, last of all, his tent—and all this under the pretext of offerings for the deities. Notwithstanding all these sacrifices, it ordinarily happens that the sick man dies, leaving all his family in complete poverty.

The principal duty of the priests is limited to the religious practices of their idolatry. Their divine service, held in the tents, consists in the united priests reciting—to the sounds of little bells, metallic plates, tambours, and gigantic trumpets—fragments of prayers, which they read from their sacred books, for the most part incomprehensible to themselves.* A priest never voluntarily speaks upon matters relating to his religion, and, if any one of his people questions him upon this subject, he never replies, giving for his reason that it is a sin to speak about religion.

The chronology of the Calmucks does not consist in reckoning the years setting out from a certain memorable date; but they count by cycles each of twelve years, to which they give a particular name of such and such an animal. The year is composed of 13 months, each of which also bears the name of an animal. Thus the first month in the year, which corresponds to our December, is called the *tiger* month; the months which follow are those of the *hare*, the *dragon*, the *serpent*, the *horse*, the *goat*, the *ape*, the *fowl*, the *dog*, the *pig*, the

*mouse*, and the *cow*. One of the months returns twice, and that is the thirteenth of the year. Each month has thirty days, and the week has seven.

The priests are greatly respected on account of their spiritual functions, and they exercise a great influence upon the whole population. It is these who are specially addressed to fix the day propitious to celebrate marriage, or to point out the kind of funeral proper for a person dead. In this last circumstance they conform to the rank, more or less important, of the deceased, or, to speak more correctly, to the greater or smaller number of sheep which the relations offer for the *khouroul*. The more liberal the offering, the more distinguished is the sepulture. But, since the rich have more means for making offerings, their bodies are ordinarily destined to be burned, while the corpse of a poor man is simply interred, or even abandoned in the midst of the steppe, to become the prey of wild animals.

The principal evil arising from this great influence of the priests over the Calmuck population is, that it is opposed to every civilizing effort; this is why all the attempts of the government to convert the Calmucks to Christianity, and to induce them to abandon their nomad life, have hitherto almost entirely failed. Moreover, the nature of the country occupied by the Calmucks is greatly opposed to their being able to establish themselves in colonies.—*Anthropological Review.*

## THE BALANCE OF LIFE IN THE AQUARIUM.

By SHIRLEY HIBBARD.

WHEN man looks upon Nature, he sees everywhere the records of death's work among the representatives of creative energy. The stratified rocks are but the tombstones in the great graveyard of the world; they cover the bones of a million generations, and their inscription is, "The dust we tread upon was once alive." If the infusion of life into countless forms, each in itself perfect, needed nothing less than Almighty power, it needed Almighty power too to complete the scheme in the institution of dissolution; and the grim king of terrors, before whom the bee and the sparrow tremble, perhaps, not less than man, became co-worker with God by a wise and beneficent appointment; and so the orders of being began, and have to this hour continued, as a series of dissolving views, in which there is no hiatus, but only *change;* no shifting of the focus or the screen, no aberration or intermission of the source of light, but an unending variety in the pictures. We know not how other worlds may fare, but this we know, that *here* death supplies from every extinguished picture the colors

with which the next are painted, and we live—man and brute—on the *débris* of the past.

I see all this and more in the aquarium; it teaches me lessons in physics, and, I trust, also teaches me that the moral and spiritual truths of the universe may be illustrated, sometimes explained, by a patient study of the commonest things. The aquarium is a world in little; it sustains itself. For the moment, I put aside the law of gravity as a universal law, and the presence of the atmosphere as a universal thing, and I call it a world, needing no aid, for its continuance and the perfect adjustment of its balance of power, from external things. I take a vessel of glass, a few pebbles, a few pieces of sandstone-rock, and a sufficiency of water, and to that I commit my fishes and insects, and say, "There is your world; the order of Nature is such that you may henceforth live and die without human interference." I say nothing here of the details of management; I am looking for instruction in the laws of life and death.

The two requisites of animal life, food and air, must be generated in this world, or it ceases to instruct me; yet the water contains but little of each, and whence is its supply to come? God has ordained such a wealth of organic forms that, wherever the conditions of life are found, life takes possession of the spot, whether it be the bottom of the ocean, the dripping roof of a cave, the expanse of the viewless air, or the mimic lake I call an aquarium. Forthwith the dead stones become alive with greenness, the glass walls assume the semblance of a meadow, the milky hue of the water disappears as the earthy particles it held in solution subside, and the light that streams through it takes a tint of greenness. There is an order of vegetation appointed to occupy such sites, and almost every non-metallic, and some metallic substances too, become speedily coated with confervæ, when their surfaces are kept moist a sufficient length of time. Were it not so, the inhabitants of my world must perish; and to prove the fact I try an experiment. I place some fishes in a clean vessel of water, without pebbles and without rock; the moment the first dim bronzy speck appears, I rub it off the glass, and so thwart the course of Nature. The fishes soon exhaust the water of its oxygen, and though the water attempts to renew its supplies by absorption from the atmosphere, the compensation is too slow, the fishes come gasping to the surface, and in a short while perish.

Even then I learn something from their death if I leave the vessel in the hands of Nature. Death has no sooner spread his black banner over my household gods than life of another kind arises to confound him, and the microscope reveals to me myriads of animals and plants, and organisms that seemingly occupy an intermediate place between the two great kingdoms, rioting upon the wreck that death has made. My half-dozen dead fishes have given birth to existences numerous as the stars in heaven, or as the sand upon the sea-shore, innumerable.

While these devour the banquet death has spread for them, while forests of confervoid threads rise in silken tufts like microscopic savannas, Nature is passing portions of the ichthyic *débris* through her laboratory, and the very source of life for which they pined and perished—oxygen—is poured in in large measure, and the corruption is quickly changed to sweetness. Of the once sportive fishes some portions have become air, other portions have become water, but the chief of their bulk lives already in the vegetation which hides their grave, and the moving throng with which that vegetation is peopled. God's purpose, in the working of the laws in obedience to which these changes have taken place, is manifestly to keep ever true that balance of life and death of which He holds the beam in His own hands.

But my aquarium which has not thus been interfered with presents already a similar scene of life and bustle. When first supplied, the milky-looking water was abundantly full of gaseous matters, and every part of the rough rockwork was, for a time studded with silvery globules. The fishes consumed all that in the process of breathing. As the water passed through their gills, the oxygen was absorbed; that oxygen, by a process of refined chemistry, and perhaps by the help of iron also, gave their gills a bright-red color, gave their blood its red color too, and, by other processes not less refined, sustained he balance of life's functions within them, for without it they must perish. We believe that not the airiest particle of earth, atmosphere, or water, nor the most minute globule of condensed moisture, nor the most infinitesimal point of meteoric dust, can ever be lost, at least during Time, from the fabric of the universe. My fishes tell me that the oxygen they absorb from the water they again return to it, but *in another form.* They *in*spire oxygen and *ex*pire carbonic acid, just as a man does, and every other living creature that moveth upon the face of all the earth. Is it within the reach of human power, even when reason, imagination, and fancy combine together as a bold triad to look direct upon a fact, to appreciate that principle of terrestrial life by which animal and vegetable organisms reciprocally labor to maintain the balance of atmospheric purity? The carbonic acid given off by the animal is poison to it, if it accumulate while the supply of oxygen is cut short. It was carbonic acid as much as absence of oxygen that killed our fishes just now, for, though inhabitants of water, they were not the less suffocated. Therefore I see *why*, in the tank that has been left alone, plants have cast anchor on the glass walls, the brown pebbles, and the gray blocks of sandstone-rock. My fishes breathe and breathe. If their numbers are properly proportioned to the area they occupy, they will never exhaust the water of oxygen, never render it fetid with carbonic acid, so long as one necessity of vegetable life—light—is allowed to use its active influence to paint the plants green, even as oxygen gives a sanguine hue to the gills or lungs of the fishes. To those plants, the carbonic acid, which the fishes

expire day and night, is as essential as oxygen is to the animal economy, and thus, without introducing a single scrap of any living plant, the balance is sustained, and death seems to be kept at a distance. If at first I threw in a tuft of callitriche or anacharis, or any other true aquatic vegetable, oxygen would be supplied abundantly; and in practice it might be well to begin so, because some little time elapses ere the seeds of the microscopic forest, the tops of whose trees present to the eye but a felt-like coating of superficial greenness, are developed into true plants; though with a fair amount of indirect daylight, and at certain seasons of the year, a few hours suffice to set the vegetative process, with all its proper consequences, in full action. Many of the readers of this paper will call to mind the aquarium that stands in my entrance-hall. It contains twenty fishes, large and small, and not a single scrap of vegetation except what has been developed *in situ* by spontaneous generation. It is three years since that was fitted and stocked, and committed to the management of Nature, with the sole exception of the external aid afforded by regular supplies of food for its inmates, which need not be taken account of, now that we are considering it as a world in which the balance of life and death is sustained by the operation of principles ordained by the Creator.

It is when we leave the principles and attempt to classify the details of the scheme that we become bewildered. The smooth revolution of the fly-wheel and the noiseless oscillation of the piston convince the unprofessional observer of a great engine that mechanical motions are possessed of poetry; but, if he would analyze the relations of the cog-wheels, the indications of the "governor," the "gauge," and the pressure-valve, he must descend to hard facts, and forget for a while the sublime suggestions of a system of mechanism that throbs like a living creature. Admit a full glare of summer sun to the aquarium, and forthwith the water loses its pellucid fluidity, and becomes deeply tinged throughout of a dull green, as if some pigment had been dissolved in it. Instead of plants attached to stones and glass only, and animals that float unseen, the whole of the water is occupied by visible masses of animal and vegetable life; and, if the fishes suffer, it will be from undue heat, not from the addition to the element in which they live of this new mass of being. Shut out the sunshine, let the fresh air play over the surface of the water, let moderate daylight stream through it as before, and speedily the green fog clears away, the water again becomes transparent, and the balance is restored. Monas, euglena, uvella, cryptomonas, gonium, and other wondrous infusoria, may be detected as constituents of the cloudy mass while it lasts, called into being because the conditions of the tank were such as they required, as if life in embryo were everywhere locked up until the moment came for its liberation, and some particular circumstance was the talisman to set it free· or, if we consider created forms to be marshalled in grand

procession, may we not expect that every tribe will hurry to its appointed place the instant that a door is opened?

Microscopists have long been at war, but without bloodshed, as to the place to be assigned to certain organic forms which are hidden from our common eyesight. While the war goes on as to whether desmidiacæ and diatomaceæ be animal or vegetable, or both, let facts suffice us here in the study of the aquarium. Does an animal exhale carbonic acid? Yes. Well, here are plants or animals, concerned in keeping up the balance, which exhale oxygen, and their name is legion. Volvox globator and the bacillariæ labor as hard to supply the fishes with the life-sustaining gas as do the silken threads of verdure that line the glass like a carpet. Is the possession of starch a distinctive feature of the vegetable? Perhaps so. Truly here are desmidiacæ that contain starch, and, if I make the possession of cilia the test for assigning certain forms to the animal kingdom, I find in the aquarium spores of algæ furnished with them. Motion I know to be no test, because algæ-spores dance through the water gayly till they find a resting-place, and, when the aquarium was first filled, it was by dancing they at last found where to pitch their tents, and cease their nomad wanderings. But they all work together to sustain the balance, and the law of "give and take" prevails among them—the stentor devours the oscillatoriæ, rotatoria, and monads, and the hydras swallow all; every darting speck is a tomb wherein some smaller speck of life is to be buried, and life thus prospers on the decay it is itself undergoing.

But all this while a fine deposit slowly settles among the pebbles, which form the lower stratum of this watery world. Between the stones a fine alluvial silt collects and thickens. The first frost, sufficiently severe to touch the tank, causes the whole green coating to peel off from the glass and rock, and, while this subsides, to add to the thickness of the alluvium—how slightly, and yet how sufficiently for an example of Nature's working!—a new growth commences, and *that* balance is restored. Do you not see that the chief teaching of geology—the piling of stratum upon stratum, the conversion of disrupted rock and decayed plant and animal into rock again—is here exemplified in the history of a domestic toy, which contains already one example of stratification in the silence of watery submergence? A tank which has been fitted with loam, pebbles, and plants of the brook and river, will, if left undisturbed for three years, be in this state. Those plants will all have decayed, but there will be an abundant spontaneous vegetation. The accumulations of that short period will have settled into a close mass, almost as hard as stone; and if fishes have died in the mean time, and have not been removed, their bones will be found overlaid with hardened mud, just as we find them in the old red sandstone, or the chalk, or the carboniferous rocks, and shall we not call them *our own* fossils? See again in this case in which

death has been very busy (for plants of large growth soon perish in the absence of sunshine, and occasional attendant accidents will carry off some of the finny pets), how life has been equally active on the other side, for such an aquarium will be a hundred times richer in those spontaneous growths we have already spoken of, and visible forms of infusoria and true zoophytes will abound, and every class will be more fully represented, down even to the twilight monad.

Though this paper must have an end, there is no end to the teaching of the aquarium. It is a watery microcosm of living and dead wonders, and we need not marvel that the balance of life and death may be observed in its succession of changes, because all the physical forces of the universe are locked up within a single bead of dew, and all the functions of organic creation are comprised in the economy of a monas termo. If God so ordains that life shall be constantly soaring from the tomb, if the story of the Phœnix ceases to be a fable, need man, the victim of doubts and fears, ever fail in his trust of that blessed promise, that "this mortal shall put on immortality, and this corruptible shall put on incorruption?" Science may fix his mind on the appreciation of God's wisdom and power as he reads the handwriting of the Almighty in Nature, but through faith in another revelation must we hope to exclaim, triumphantly, "O death, where is thy sting? O grave, where is thy victory?" Or, to pass from divine to human consolations, we may take up the apostrophe of the great Raleigh, and say: "O eloquent, just, and mighty Death! what none have dared, thou hast done; what none have attempted, thou hast accomplished; thou hast gathered all the might, majesty, and meanness of mankind, and hast covered them with these two words, '*hic jacet.*'" Nature's children have a dread of death, but Nature herself is in friendly compact with the master of silence. If the *types* which are the ideas of God have survived from the oldest rocks to this present hour, will not the spirit which lives on ideas, and evolves them as the aquarium evolves its throng of animalcules, live forever? It is not hard to believe with Tennyson—

> "That nothing walks with aimless feet,
> That not one life shall be destroyed,
> Or cast as rubbish to the void,
> When God hath made the pile complete."

"The pile" will be complete when God's purpose is fulfilled in man, to whom it is given to hope after eternal life, and with eyes of faith to pierce through the veil, and behold the wondrous things of eternity.—*Recreative Science.*

# JURIES, JUDGES, AND INSANITY.

By Dr. HENRY MAUDSLEY.

THE recent trials for murder, in which insanity has been alleged for the defence, whatever differences of opinion they may have given rise to, have clearly shown how entirely unfitted a common jury is to decide the delicate and difficult question of a prisoner's mental state. Had the wit of man been employed to devise a tribunal more unfitted for such a purpose, it might have exhausted itself in the vain attempt. It is one of the anomalies of British jurisprudence that while in an action for libel or any civil injury a special jury may be claimed, and the services of men who are above the lowest levels of ignorance and prejudice be thus obtained, it is quite otherwise when a person is on trial for his life. In this most momentous issue, however complicated the circumstances, however obscure the facts, he must stand the verdict of twelve common jurymen. In ordinary cases of murder, when the facts are such as any person of average sense and experience may judge of, the system works sufficiently well, or at any rate no great harm ensues; but, in any case in which it is necessary to form a judgment upon scientific data, a common jury is assuredly a singulary incompetent tribunal. The very terms of science they are ignorant of, and they either accept the data blindly on the authority of a skilled witness, or reject them blindly from the prejudice of ignorance. The former result is commonly what happens in regard to scientific evidence of poisoning; the latter is commonly what happens in regard to scientific evidence of insanity. There are few persons who, without having had a special chemical training, would venture to give an opinion on the value of the chemical evidence given in a case of poisoning, but everybody thinks himself competent to say when a man is mad; and, as the common opinion as to an insane person is that he is either a raging maniac or an idiot, it is no wonder that juries are prone to reject the theory of insanity which is propounded to them by medical men acquainted with its manifold varieties. It would seem to be an elementary principle of justice that a prisoner on trial for his life should have the right to claim a jury of men specially competent, or at any rate not absolutely incompetent, to judge of the facts on which his defence is to be based.

It is an additional evil of the present system that judges too often share the ignorance of juries, and surpass them in the arrogant presumption which springs from ignorance. Instead of urging them to throw off all prejudice, and aiding them with right information, they sometimes strengthen their prejudices by sneers at the medical evidence, and directly mislead them by laying down false doctrines. They may even go so far as to flatter them in the opinion that they, as

men of common-sense, are quite as well able as medical men to say whether a person is insane or not. In the last number of this Journal we gave a report of a trial which took place in Scotland for the reduction of a will, in which the judge directed the jury, with the greatest assurance, that the symptoms which preceded insanity and indicated its approach, in an ordinary case, went on increasing as the disease advanced, and implied that, as they had not done so in the case in question, it was preposterous to allege insanity.

To our mind, the evidence of insanity in that case was conclusive, but at any rate the statement of the judge was utterly untrue, as a very little knowledge of insanity would have taught him; and we cannot help thinking that the authoritative enunciation of such false doctrine to a jury is nothing less than a judicial misdemeanor. One cannot justly complain that judges should be ignorant of insanity, seeing that only by long experience and study is a true knowledge of it to be acquired; but it is a fair ground of complaint that, being ignorant, they should speak as confidently and as foolishly as they sometimes do. Here, as in other scientific matters, it is not intuition, but experience, which giveth understanding.

Not only is it the fact that judges are ignorant, but they are too often hostile. Governed by the old and barbarous dictum that knowledge of right and wrong is the proper criterion of responsibility when insanity is alleged, they resent angrily the allegation of insanity in any case in which the person has not lost all knowledge of right and wrong. Believing that medical men are striving to snatch the accused person from their jurisdiction, they are jealous of interference, are eager to secure a conviction, and sometimes lose the impartiality becoming the judge in the zeal proper to the partisan. The reporters are happily good to them, in forbearing to report all they say and do, or we fear that the dignity of the bench would have suffered more in public estimation even than it has done of late years.

It is useless to say smooth things when things are not smooth. There is a direct conflict between medical knowledge and judge-made law,[1] which must go on until bad law is superseded by just principles

[1] Dr. Landor says: "If the principle that it is essential to institute a thorough examination of the individual's past and present condition before determining his state of mind is the right one, then the proceedings of lawyers are in complete antagonism to truth. There can be no conflict between propositions more complete. Medicine declares that insanity is a physical and corporeal disease; Law, that it is not. Medicine says that imbecility and insanity are different conditions; Law, that they are identical. Medicine asserts that a theoretical study of mental diseases and defects is necessary to a proper understanding of such diseases and defects; Law denies this, and says that insanity is a fact to be determined by any dozen of ordinary men, in consultation, on the case, selected at random from any class of the population. Medicine says that a man may be insane and irresponsible, and yet know right from wrong; Law says that a knowledge of right and wrong is the test both of soundness of mind and responsibility to the law. Medicine says restrain and cure the insane and imbecile sufferer. The object of the ac-

in harmony with the teachings of science. For many years, by all authorities on insanity, in season and out of season, the truth has been in vain proclaimed: many times have futile attempts been made to arouse attention to the iniquity of the law as laid down by the judges; but it is still necessary for us to go on protesting, as our forefathers did, and as our children's children may have to do. We may, at any rate, take leave to characterize the administration of the law on every occasion in the plain terms which it deserves. Under the name of justice, grievous injustice has sometimes been done, and it would be easy to point to more than one instance in which murder has been avenged by the judicial murder of an insane and irresponsible person. The saddest and most humiliating disease with which mankind is afflicted, and which should rightly make the sufferer an object of the deepest compassion, only avails in England in the nineteenth century to bring him, in the event of his doing violence, to the edge of the scaffold or over it. To this point have eighteen hundred and seventy-two years of Christianity brought us! And Science protests in vain! Without laying claim to much gift of prophecy, one may, perhaps, venture to predict that the time will come when the inhabitants of the earth will look back upon us with astonishment and horror, not otherwise than as we now look back upon the execution of old women for witchcraft in past times—a barbarity which the judges were the last to be willing to abandon, which they clung to long after it had been condemned by enlightened opinion. Indeed, there has not been, as Mr. Bright once said in the House of Commons, a single modification of the law in the direction of mercy and justice which has not been opposed by the judges!

The ground which medical men should firmly and consistently take in regard to insanity is, that it is a physical disease; that they alone are competent to decide upon its presence or absence; and that it is quite as absurd for lawyers or the general public to give their opinion on the subject in a doubtful case, as it would be for them to do so in a case of fever. For what can they know of its predisposing and exciting

tion of the law is punishment, and, if its severity is mitigated, it is not by the law, but by the suspension of the law, by authority above the law. The Law is thus entirely antagonistic to Medicine on all those questions of mental science which involve the freedom and well-being of the imbecile and the insane, and which often determine whether they shall be put to an ignominious death or not, whether they shall be deprived of their property or suffered to retain it. This antagonism is, therefore, a most serious matter to the insane, their friends and families, not less serious to judges and legislators, and of the deepest interest to both medical and legal professions. For with such opinions inculcated by the law, existing ignorances are more deeply rooted in the public mind, so that the difficulty in treating the insane by medical men, and in giving testimony in courts, is greatly increased, especially when great judges remark (influenced, no doubt, by the degrading exhibition of opposing bitterness of medical men in courts), that 'the introduction of medical opinions and theories on this subject has proceeded from the vicious principle of considering insanity a disease, whereas it is a fact to be ascertained by evidence, in like manner as any other fact, and no more is necessary than to try the question by proof of the habits, the demeanor, conversation, and acts of the alleged lunatic.'"

causes, its premonitory symptoms, its occasional sudden accession, its remissions and intermissions, its various phases of depression, excitement, or violence, its different symptoms and its probable termination? Only by careful observation of the disease can its real character be known, and its symptoms be rightly interpreted: from this firm base Medicine should refuse to be moved.

It is said sometimes, however, in vindication of the law, that it does not and cannot attempt to apportion exactly the individual responsibility, but that it looks to the great interests of society, and inflicts punishment in order to deter others from crime. The well-known writer, W. R. G., in a letter to the *Pall Mall Gazette*, has recently given forcible expression to this principle, and maintains that, if men would get a firm grasp of it, the conflicts which now occur would cease. He quotes with approbation the saying of the judge who, in sentencing a prisoner to death for sheep-stealing, said: "I do not sentence you to be hanged for stealing sheep, but I sentence you to be hanged in order that sheep may not be stolen." Here we see how entirely the writer has failed to grasp the real nature of insanity *as a disease*, for which the sufferer is not responsible, and which renders him irresponsible for what he does. Were one-half the lunatic population of the country hanged, the spectacle would have no effect upon the insane person who cannot help doing what he does. If a boy in school were wilfully to pull faces and make strange antics, the master might justly punish him, and the punishment would probably deter other boys from following his example, but it would have no deterrent effect upon the unfortunate boy whose grimaces and antics were produced against his will by chorea. The one is a proper object of punishment; the other is a sad object of compassion, whom it would be a barbarous and cruel thing to punish. To execute a madman is no punishment to him, and no warning to other madmen, but a punishment to those who see in it, to use the words of Sir E. Coke, "a miserable spectacle, both against law, and of extreme inhumanity and cruelty, and which can be no example to others."

Moreover, it is not necessary to hang a lunatic in order to protect society, or in order to punish him, for it can protect itself sufficiently well by shutting him up in an asylum; and the prospect of being confined in a lunatic asylum is not one which is likely to encourage a man to do a murder; on the contrary, it is one which excites as much horror and antipathy in the minds of both sane and insane persons as can well be imagined.

And, finally, as the law did not prevent sheep-stealing by hanging sheep-stealers, but brought itself into discredit by offending the moral sense of mankind; so, likewise, it will not, by hanging madmen, prevent insane persons from doing murder, but must inevitably bring itself into contempt by offending the moral sense of mankind. Is not this result happening now? Has Mr. Baron Martin added any thing

to the strength and dignity of the Bench by his conduct in the recent trial of Christiana Edmunds? That conduct has elicited such comments from all quarters as it has not often before happened in this country to find made on the administration of justice; and, if the law has not been brought into contempt, it has received a rude shock among a law-abiding people. The uncertainty which now exists, whether a person shall be convicted as a criminal or acquitted as insane, and the accidental character of the result, cannot fail to be injurious to the welfare of society. And if the present agitation subsides, as former agitations have subsided, without any step in advance being made, the bad law is none the less certainly doomed. As we have said on a former occasion, "men will go mad, and madmen will commit crimes, and in spite of prejudice, and in spite of clamor, Science will declare the truth. Juries, too, will now and then be found enlightened enough to appreciate it: and if the voice of Justice be unsuccessfully raised, it will be but a doubtful triumph for prejudice when Science shall say, 'You have hanged a madman.'"

It will not be of much use to point out once more, what has been pointed out over and over again, that the manner in which scientific evidence is procured and taken in courts of justice is very ill-fitted to elicit the truth and to further the ends of justice. One side procures its scientific witness, and the other side procures its scientific witness, each of whom is necessarily, though it may be involuntarily, biassed in favor of the side on which he is called to give evidence—biassed by his wishes, or interests, or passions, or pretensions. It is not in human nature entirely to escape some bias under such circumstances. In due course he is called into the witness-box and examined by those who only wish to elicit just as much as will serve their purpose; he is then cross-examined by those whose aim is to elicit something that will serve their purpose; and the end of the matter seldom is "the truth, the whole truth, and nothing but the truth." Having regard to the entire ignorance of scientific matters which counsel, jury, and judge show, it may be truly said that the present system of taking scientific evidence is as bad as it well can be, and that it completely fails in what should be its object—to elicit truth and to administer justice. "The incompetency of a court, as ordinarily constituted, is," as we have formerly said, "practically recognized in a class of cases known as Admiralty cases, where the judge is assisted by assessors of competent skill and knowledge in the technical matters under consideration. Moreover, by the 15th and 16th Vict., c. 80, s. 42, the Court of Chancery, or any judge thereof, is empowered, in such way as he may think fit, to obtain the assistance of accountants, merchants, engineers, actuaries, or other scientific persons, the better to enable such court or judge to determine any matter at issue in any cause or proceeding, and to act upon the certificate of such persons." The Lords Justices seldom, if ever, decide on a question of insanity without calling for a

report upon the case from one of the Medical Visitors in Lunacy. If the English law were not more careful about property than about life, it would long ago have acted upon this principle in criminal trials.

However, he who advocates a reform in the legal proceedings of this country is assuredly a voice crying in the wilderness, and with less result than the Baptist had when he cried aloud there. It is not likely that any thing we can say will induce those who have the privilege or pain of constituting our government to leave for a time the ambitious struggles of politics, and to devote their energies to a reform of the law. And yet a government could not be better employed than in laboring to effect such a reform. A system of just laws and a simple and expeditious administration of justice would assuredly conduce more to the welfare of the community than years of parliamentary squabbles about politics. Many parliamentary questions which have occupied much time and made a great show in their day will look very small, if they are ever heard of at all, in history, while the reputations that grew out of them will have been lost in oblivion; but an effectual reform of the jurisprudence of the country, which is now an urgent need, would be a lasting benefit to the community, and an eternal honor to the statesman who initiated and carried it through.—*Abstract from the Journal of Mental Science.*

## CONCERNING CORPULENCE.

By W. J. YOUMANS, M. D.

MR. BANTING had defective hearing, and consulted a physician for his deafness. The doctor was William Harvey, aural surgeon to the Royal Dispensary for Diseases of the Ear, and also for the great Northern Hospital of London. Dr. Harvey told the patient that his deafness was complicated with his corpulence, for Mr. Banting was very fat. He told him that, to improve his hearing, it would be necessary to reduce his obesity, and he prescribed a diet for the purpose. This was good news for Mr. Banting; he had come to get his ears syringed for deafness, and a way was pointed out by which he could get back his hearing and get rid of his burden of adipose at the same time. He commenced the dietetic treatment, and so successful did it prove in relieving his corpulence, that he rushed into print to convey the glad tidings to all over-unctuous people. He thus became immortal as a philanthropist, and enriched our speech with a new term —*Bantingism*—which will last as long as the literature of fatness endures. Banting was, however, only a layman, after all, and his ambition was satisfied to produce a pamphlet; but now comes the doc-

tor himself, with his regular treatise "On Corpulence in Relation to Disease." Dr. Harvey's book is an excellent summary of the subject, and has the weight of professional and scientific authority; the present article is mainly condensed from his pages:

The manner in which fat is distributed over the body is now generally understood to be by the texture of the cellular membrane. Formerly it was thought to adhere in clusters to the parts where it was found—a mistake that has been corrected by the study of minute anatomy. The cellular tissue, as its name implies, is made up of great numbers of minute cells, which communicate with each other, and which are formed by the interlacings of fine, soft, colorless, elastic threads, intermixed with delicate films or laminæ, the tissue presenting, when free from fat, a white, fleecy aspect. This tissue is found everywhere underneath the skin; the serous and mucous membranes are attached by it to subjacent parts; it lies between the muscles, and also among their fibres, surrounds the blood-vessels, and is generally distributed throughout the body. In certain situations, as around the large blood-vessels and nerves, in the omentum and mesentery, about the joints, and especially under the skin, the cells enclose what are known as *adipose vesicles*, minute spherical pouches, filled with fat or oil; and, when these are present in notable quantity, the structure takes the name of adipose tissue. As thus deposited, the fat appears merely to be held in store, as it remains quite distinct in form and situation from other parts of the animal frame. It, however, enters largely into the composition of nerve-substance, where it becomes an essential part of a highly-organized tissue.

The development of fatty tissue varies considerably at different ages, and in the two sexes. In children and in females, especially in early age, the principal seat of the fatty deposit is in the cellular tissue, immediately under the skin. During adolescence, the fat has a tendency to disappear from this situation; but, about middle age, frequently becomes again deposited, not only in the subcutaneous tissues, but also in the neighborhood of certain internal viscera. The quality of the fat also varies, both with the age and with the part in which it is deposited. It is firmer and higher colored in old persons than in young ones; and is more condensed and solid in parts liable to compression, than in the omentum, or about the heart, stomach, and intestines.

A moderate amount of fat is a sign of good health, and physiologists generally allow that it ought to form about the twentieth part of the weight of a man, and the sixteenth of a woman. Independently of its importance as a non-conducting substance in impeding the too rapid escape of animal heat, fat may also be regarded as a store of material to compensate for waste of tissue, under sickness, or other circumstances, entailing temporary abstinence from food. But when fat accumulates to the extent of interfering with important functions, and

becomes a load and a drag, impeding the respiratory movements, making exercise painful, and dulling the sensibilities, it is then not only a source of great discomfort, but the precursor of positive disease.

In a perfectly healthy individual, no abnormal deposition of fat can be supposed to take place, at any age or in any locality, provided the natural appetites and muscular powers be regulated as they ought. Whenever, therefore, we see an individual unnaturally fat or lean, we may safely conclude that an error exists somewhere, and that such an individual either inherits a morbid propensity, or is producing for himself such a propensity.

The conditions which appear to favor an excessive deposit of fat are the following: First, an inherited tendency which predisposes to corpulence, yet always requiring the influence of some exciting cause to bring it into activity. No one can doubt that certain families have a natural tendency to corpulence, which can be often traced through successive generations. It is curious, also, to observe how this tendency is varied in different families, and even in different individuals of the same family. Thus, in one family, we see that the children and females possess a striking tendency to *embonpoint*, while the male adults, particularly in advanced age, are remarkable for their leanness. In another family, directly the reverse may be observed, the children and females are lean and squalid, while the middle-aged male adults are conspicuous for their corpulence.

Climate and locality seem also to exert considerable influence on the deposition of fat. The inhabitants of low, swampy situations, in temperate climates, are usually remarkable for their bulky flabbiness, and propensity to corpulence; while the inhabitants of very hot and of very cold climates, as well as the inhabitants of mountainous regions, have, perhaps, less tendency to obesity. There is this remarkable difference, however, between the dwellers in hot, and in cold climates: those living in hot climates rarely become fat, without becoming otherwise diseased; while the people of cold climates seem not only to derive protection against the influence of external cold by the layer of fat with which their bodies may be enveloped, but the carbon of the fat, combining with oxygen during the process of secondary assimilation, has with some reason been supposed to contribute to the production of animal heat.

But, of all the agencies which influence the deposition of fat, probably diet and exercise are the most important. Foods have been divided, according to their composition, into nitrogenous and non-nitrogenous. The former, including albumen, fibrine, and casein, consist of only carbon, hydrogen, oxygen, and nitrogen, with some minor ingredients; the latter, embracing starch, sugar, and the fats, are made up of only carbon, hydrogen, and oxygen. It has been thought that the nitrogenous foods are consumed chiefly in the formation of the tissues, while the non-nitrogenous are devoted mainly to the function of

respiration, going principally to the maintenance of the animal temperature. Whatever basis in fact this view may have, it is pretty well established that the substances belonging to the latter class of foods are especially favorable to the production of fat, when taken into the system. This fat may exist ready formed in the food, as it is furnished abundantly by both the animal and vegetable kingdoms; or, as is held by many physiologists, it may be formed in the system by the chemical transformation of starch and sugar. Numerous experiments have been made on geese, ducks, pigs, bees, etc., which go to prove that these animals accumulate much more fat than can be accounted for by the quantity present in the food. M. Flourens had the bears in the Jardin des Plantes fed exclusively on bread, and they became excessively fat. Bees confined to a diet of purified sugar continue to produce wax, which strictly belongs to the group of fats. But, whatever its source, the excessive use of non-nitrogenous food, conjoined with inactivity, frequently leads to the deposit of an inordinate amount of oleaginous matter. This fact is illustrated by numerous instances both among the lower animals and among men. At Strasbourg, the geese are fattened by shutting them up in darkened coops within a heated room, and stuffing them constantly with food. The high temperature lessens the escape of heat, and thus favors the process. Here all the conditions for insuring obesity are resorted to—viz., external heat, obscurity, inactivity, and the cramming of the animals with fattening food. A still greater refinement for pandering to the appetite is resorted to by the Italians who relish the fat of the ortolan. To procure this in perfection the natural habits of the bird were watched, and, it having been found that it only takes food at the rising of the sun, they cheat the birds by producing an artificial sunrise. To effect this, the ortolans are placed in a dark, warm chamber which has but one aperture in the wall. Food being scattered over the floor, a lantern is placed at a certain hour in the opening, when the birds, misled by the dim light, at once commence feeding. The meal finished, the lantern is withdrawn, and more food scattered about, when the ortolans sleep. Two or three hours having elapsed, and digestion being completed, the lantern is again made to throw its light into the apartment. The rising sun recalls the birds to the habit of again feeding; and they again sleep with returning darkness. This process is repeated several times in the twenty-four hours, and in a very short time the ortolan becomes literally a ball of fat, which, strung on a wick, is said to make an excellent lamp.

It is known that farinaceous and vegetable foods are fattening, and saccharine matters are especially so. The instance of laborers in Italy, who get fat during the grape and fig season, has been frequently quoted. In sugar-growing countries, the negroes and cattle employed on the plantations grow remarkably stout while the cane is being gathered and the sugar extracted. During this harvest the saccharine

juices are freely consumed, but, when the season is over, the superabundant adipose tissue is gradually lost. It is said that, among the Asiatics, there are Bramins who pride themselves on their extreme corpulency. Their diet consists of farinaceous vegetables, milk, sugar, sweetmeats, and ghee, a species of Indian butter. Dr. Fothergill remarks, that a strictly vegetable diet produces excess of fat more certainly than other means.

The use of a large amount of liquid in the diet also favors the deposit of fat. Alcoholic drinks are especially objectionable in this respect, for, according to Dr. Harvey, the elements which are chemically convertible into fat are rendered more fattening if alcoholic liquids be added to them in the stomach; perhaps, because of the power which alcoholic liquids possess of lessening or delaying destructive metamorphosis.

Inactivity, by decreasing waste in the system, acts in a negative way toward the production of obesity. In order to fatten animals, they are habitually confined, and, if the process is to be a rapid one, they are kept in the dark as a means of securing the utmost quiet. Now, indolence on the part of the human animal, associated, as it generally is, with excessive eating and drinking, and much sleep, constitutes a similar set of conditions, and is likely to lead to a similar result.

The consequences of obesity are often more serious than is generally believed. To put aside the many minor inconveniences, which, however, may be sufficiently annoying to make the sufferer desirous of reducing his weight, it may be taken as a general rule that obesity does not conduce to longevity. Usually it is accompanied with diminished vital power; there are disturbances of the organs of respiration, circulation, and digestion. The blood is proportionately deficient in quantity or quality, and the muscles are weak and have but little firmness. And, although the disposition is often sanguine, so that the sufferer continues lively and cheerful, and has the happy habit of looking at the best side of every thing, yet physical and mental occupations are generally uncongenial. There are several notable exceptions to this, however, and many can call to mind cases where both the bodily and mental habits are quite as active in the obese as in others. Maccaz gives the case of an enormously fat man, whom he met at Pavia, that was celebrated as a dancer, and whose movements were exceedingly agile and graceful. David Hume and Napoleon may be instanced as examples where corpulence was associated with great mental powers; and Raggi, an Italian physician, who was an eminent authority on corpulence, relates numerous cases of extreme obesity in which the intellect remained quite alert to the last. Nevertheless, the rule holds good that extreme fatness is very much in the way of either bodily or mental work.

By an over-development of adipose tissue the capillary system of

blood-vessels is vastly increased in aggregate bulk, while at the same time no corresponding increase takes place in the forces which supply the means of action to those capillaries. Hence there is a comparative weakness in the conservative vital processes, and any injury to a part, especially if remotely situated, is less easily repaired.

The senses of hearing, taste, and smell, are frequently much impaired in corpulent people, a condition due in the majority of cases, according to Dr. Harvey, to deposits of fat in the organs concerned. The nasal passages, mouth, and throat, are, as all know, lined with mucous membrane, which continues through the Eustachian tubes into the middle ear. This mucous membrane may become the seat of a fatty deposit, and thus impair the function of the part. The sense of smell depends upon the contact of odorous emanations with the sensitive olfactory membrane, and such contact can only take place when there is a free passage for them through the nose. If the nasal membranes become thickened from any cause, thus partially or wholly preventing the passage of air, the capacity of smell is correspondingly affected. The sense of taste, which, to according many physiologists, is properly limited to the perception of the acid, bitter, sweet, or saline properties of food, does not appear to suffer; but the power to recognize and enjoy flavors, which is commonly associated with taste, but which in reality belongs to the nose, is sometimes lost along with the sense of smell. Access of air to the middle ear through the Eustachian tubes is an essential to the sense of hearing, and this, too, is greatly interfered with oftentimes by the fatty thickening of the mucous membrane of the nose and throat. At all events, whatever the nature of the cause, it has resulted, in great numbers of cases where corpulence was attended by these defects of sense, that removal of the deposit by a proper dietary has been immediately followed by recovery, after all sorts of local remedies had failed to afford relief.

Dr. Harvey thinks that both gout and rheumatism are aggravated by corpulence. Another troublesome attendant is a tendency to the formation of gravel and calculus. In regard to this, Dr. Harvey states that, after the usual remedies prescribed for its relief have completely failed, he has seen a well-directed dietary, designed with a view to restraining the formation of adipose, completely successful in finally preventing these distressing formations.

Although obesity may be ranked among the diseases arising from original imperfection in the functions of some of the organs, it is also, without doubt, most intimately connected with our habits of life. The inconveniences arising from it are, therefore, to be removed by correcting those habits, especially such as relate to diet and regimen. Drugs without number have been tried, both for the removal of corpulence itself, and for the many troubles to which it gives rise; but they have almost uniformly failed when diet and exercise have been neglected. On the other hand, attention to these points, persistently carried out,

has been as uniformly followed by improvement without the aid of medicine. It is a true maxim in physic that diseases which are long in their advancement are, as a rule, only to be remedied by long-continued curative attention. Common-sense proves the fallacy of expecting to eradicate old-established errors of the body by any sudden remedies; the diet and medical regimen of such persons should therefore be undeviatingly suited to their disordered tendencies, and resolutely maintained as long as they afford any hope of relief.

We have seen that certain foods, such as the fats themselves, and others that consist principally of starch or sugar, favor the development of corpulence; and it will be observed that in the following dietary designed by Dr. Harvey, and prescribed by him in the famous case of Banting, foods of this class are reduced to a minimum, though not altogether interdicted, the nitrogenous foods being correspondingly increased.

*Breakfast.*—Four to six ounces of meat, two ounces of biscuit or toast, and a large cup of tea, but without milk or sugar.

*Dinner.*—Ten to twelve ounces of any fish except salmon; any vegetable except potatoes and vegetable roots; any kind of poultry or venison, and two ounces of toasted bread. With it drink two or three glasses of good red wine, sherry or madeira, avoiding champagne, port, or beer.

In the afternoon, four to six ounces of fruit, one or two biscuits, and again a large cup of tea without milk or sugar.

*Supper.*—Six to eight ounces of meat or fish, and one or two glasses of red wine.

Dr. Harvey remarks: "When once the body has reached its full development in manhood, the quantity and quality of the food should be regulated by the demand made by the wear and tear of the system. If, for instance, a person, already sufficiently stout, is growing fatter and fatter, he is taking more fattening food than is necessary or safe, and must restrict himself if he would restore the balance of the functions."

## THE STUDY OF PHYSICAL SCIENCE.

### A LECTURE TO YOUNG MEN.

By Rev. CHARLES KINGSLEY.

SOME of you may ask, and you have a perfect right to ask, why I, a clergyman, have chosen this subject for my lecture? Why do I wish to teach young men physical science? What good will the right understanding of astronomy or of chemistry, or of the stones under their feet, or of the plants or animals which they meet—What good, I say, will that do them?

In the first place, they need, I presume, occupation after their hours of work; and to give that this class was established. If any of them answer, "We do not want occupation, we want amusement. Work is very dull, and we want something which will excite our fancy, imagination, sense of humor. We want poetry, fiction, even a good laugh or a game of play"—I shall most fully agree with them. There is often no better medicine for a hard-worked body and mind than a good laugh; and the man that can play most heartily when he has a chance is generally the man who can work most heartily when he must work. But there is certainly nothing in the study of physical science to interfere with genial hilarity. Indeed, some solemn persons have been wont to reprove the members of the British Association, and specially that Red Lion Club, where all the philosophers are expected to lash their tails and roar, of being somewhat too fond of mere and sheer fun, after the abstruse papers of the day are read and discussed. And as for harmless amusement, and still more for the free exercise of the fancy and the imagination, I know few studies to compare with Natural History; with the search for the most beautiful and curious productions of Nature amid her loveliest scenery, and in her freshest atmosphere. I have known again and again working-men who in the midst of smoky cities have kept their bodies, their minds, and their hearts healthy and pure by going out into the country at odd hours, and making collections of plants, insects, birds, or some other objects of natural history; and I doubt not that such will be the case with some of you.

Another argument, and a very strong one, in favor of studying some branch of physical science just now is this—that without it you can hardly keep pace with the thought of the world around you.

Over and above the solid gain of a scientific habit of mind, of which I shall speak presently, the gain of mere facts, the increased knowledge of this planet on which we live, is very valuable just now; valuable certainly to all who do not wish their children and their younger brothers to know more about the universe than they do.

Natural science is now occupying a more and more important place in education. Oxford, Cambridge, the London University, the public schools one after another, are taking up the subject in earnest; so are the middle-class schools; so, I trust, will all primary schools throughout the country; and I hope that my children, at least, if not I myself, will see the day, when ignorance of the primary laws and facts of science will be looked on as a defect, only second to ignorance of the primary laws of religion and morality.

I speak strongly, but deliberately. It does seem to me strange, to use the mildest word, that people whose destiny it is to live, even for a few short years, on this planet which we call the earth, and who do not at all intend to live on it as hermits, shutting themseves up in cells, and looking on death as an escape and a deliverance, but intend to live

as comfortably and wholesomely as they can, they and their children after them—it seems strange, I say, that such people should in general be so careless about the constitution of this same planet, and of the laws and facts on which depend, not merely their comfort and their wealth, but their health and their very lives, and the health and the lives of their children and descendants.

I know some will say, at least to themselves, "What need for us to study science? There are plenty to do that already; and we shall be sure sooner or later to profit by their discoveries; and meanwhile it is not science which is needed to make mankind thrive, but simple common-sense."

I should reply that, to expect to profit by other men's discoveries when you do not pay for them—to let others labor in the hope of entering into their labors, is not a very noble or generous state of mind—comparable somewhat, I should say, to that of the fatting ox, who willingly allows the farmer to house him, till for him, feed for him, provided only he himself may lounge in his stall, and eat, and *not* be thankful. There is one difference in the two cases, but only one—that while the farmer can repay himself by eating the ox, the scientific man cannot repay himself by eating you; and so never gets paid, in most cases, at all.

But as for mankind thriving by common-sense: they have not thriven by common-sense, because they have not used their common-sense according to that regulated method which is called science. In no age, in no country, as yet, have the majority of mankind been guided, I will not say by the love of God, and by the fear of God, but not even by sense and reason. Not sense and reason, but nonsense and unreason—prejudice and fancy—greed and haste—have led them to such results as were to be expected—to superstitions, persecutions, wars, famines, pestilence, hereditary disease, poverty, waste—waste incalculable, and now too often irremediable—waste of life, of labor, of capital, of raw material, of soil, of manure, of every bounty which God has bestowed on man, till, as in the eastern Mediterranean, whole countries, some of the finest in the world, seem ruined forever: and all because men will not learn nor obey those physical laws of the universe which (whether we be conscious of them or not) are all around us, like walls of iron and of adamant—say rather, like some vast machine, ruthless though beneficent, among the wheels of which, if we entangle ourselves in our rash ignorance, they will not stop to set us free, but crush us, as they have crushed whole nations and whole races ere now to powder. Very terrible, though very calm, is outraged Nature:

> "Though the mills of God grind
> Slowly, yet they grind exceeding small.
> Though He sit, and wait with patience,
> With exactness grinds He all."

It is, I believe, one of the most hopeful among the many hopeful

signs of the times, that the civilized nations of Europe and America are awakening, slowly but surely, to this truth. The civilized world is learning, thank God, more and more of the importance of physical science; year by year, thank God, it is learning to live more and more according to the laws of physical science, which are, as the great Lord Bacon said of old, none other than "Vox Dei in rebus revelata"—the voice of God vevealed in facts; and it is gaining, by so doing, year by year, more and more of health and wealth; of peaceful and comfortable, even of graceful and elevating, means of life for fresh millions.

If you want to know what the study of physical science has done for man, look, as a single instance, at the science of sanitary reform; the science which does not merely go to cure disease, and shut the stable-door after the horse is stolen, but tries to prevent disease; and, thank God, is succeeding beyond our highest expectations. Or look at the actual fresh amount of employment, of subsistence, which science has, during the last century, given to men, and judge for yourselves whether the study of it be not one worthy of those who wish to help themselves, and, in so doing, to help their fellow-men. Let me quote to you a passage from an essay urging the institution of schools of physical science for artisans, which says all which I wish to say and more:

"The discoveries of voltaic electricity, electro-magnetism, and magnetic electricity, by Volta, Oersted, and Faraday, led to the invention of electric telegraphy by Wheatstone and others, and to the great manufacturers of telegraph-cables and telegraph-wire, and of the materials required for them. The value of the cargo of the Great Eastern alone in the present Bombay telegraph expedition is calculated at three million pounds sterling. It also led to the employment of thousands of operators to transmit the telegraphic messages, and to a great increase of our commerce in nearly all its branches by the more rapid means of communication. The discovery of voltaic electricity further led to the invention of electro-plating, and to the employment of a large number of persons in that business. The numerous experimental researches on specific heat, latent heat, the tension of vapors, the properties of water, the mechanical effect of heat, etc., resulted in the development of steam-engines and railways, and the almost endless employments depending upon their construction and use. About a quarter of a million of persons are employed on railways alone in Great Britain. The various original investigations on the chemical effects of light led to the invention of photography, and have given employment to thousands of persons who practise that process, or manufacture and prepare the various material and articles required in it. The discovery of chlorine by Scheele led to the invention of the modern processes of bleaching, and to various improvements in the dyeing of the textile fabrics, and has given employment to a very large number of our Lancashire operatives. The discovery of chlorine has also contrib-

uted to the employment of thousands of printers, by enabling Esparto grass to be bleached and formed into paper for the use of our daily press. The numerous experimental investigations in relation to coal-gas have been the means of extending the use of that substance, and of increasing the employment of workmen and others connected with its manufacture. The discovery of the alkaline metals by Davy, of cyanide of potassium, of nickel, phosphorus, the common acids, and a multitude of other substances, has led to the employment of a whole army of workmen in the conversion of those substances into articles of utility. The foregoing examples might be greatly enlarged upon, and a great many others might be selected from the sciences of physics and chemistry: but those mentioned will suffice. There is not a force of Nature, nor scarcely a material substance that we employ, which has not been the subject of several, and in some cases of numerous, original experimental researches, many of which have resulted, in a greater or less degree, in increasing the employment for workmen and others."—(*Nature*, No. 25.)

Suppose that any one of you, learning a little sound natural history, should observe nothing but the hedgerow-plants, he would find that there is much more to be seen in those mere hedgerow-plants than he fancies now. The microscope will reveal to him in the tissues of any wood, of any seed, wonders which will first amuse him, then puzzle him, and at last (I hope) awe him, as he perceives that smallness of size interferes in no way with perfection of development, and that "Nature," as has been well said, "is greatest in that which is least." And more. Suppose that he went further still. Suppose that he extended his researches somewhat to those minuter vegetable forms, the mosses, fungi, lichens. Suppose that he went a little further still, and tried what the microscope would show him in any stagnant pool, whether fresh water or salt, of Desmidiæ, Diatoms, and all those wondrous atomies which seem as yet to defy our classification into plants or animals. Suppose he learned something of this, but nothing of aught else. Would he have gained no solid wisdom? He would be a stupider man than I have a right to believe any of you to be, if he had not gained thereby somewhat of the most valuable of treasures, namely, that scientific habit of mind which (as has been well said) is only common-sense well regulated, the art of seeing; the art of knowing what he sees; the art of comparing, of perceiving true likenesses and true differences, and so of classifying and arranging what he sees; the art of connecting facts together in his own mind, in chains of cause and effect; and that accurately, patiently, calmly, without prejudice, vanity, or temper. Accuracy, patience, freedom from prejudice, carelessness for all except the truth, whatever the truth may be—are not these virtues which it is worth any trouble to gain? Virtues, not merely of the intellect, but of the character; which, once gained, a man can apply to all subjects, and employ for the acquisition of all solid knowl-

edge. And I know no study whatsoever more able to help a man to acquire that inductive habit of mind than natural history.

True, it may be acquired otherwise. The study of languages, for instance, when properly pursued, helps specially to form it, because words are facts, and the modern science of philology, which deals with them, has become now a thoroughly inductive, and therefore a trustworthy and a teaching science. But without that scientific temper of mind which judges calmly of facts, no good or lasting work will be done, whether in physical science, in social science, in politics, in philosophy, in philology, or in history.

Now, if this scientific habit of mind can be gained by other studies, why should I, as a clergyman, interest myself specially in the spread of physical science? Am I not going out of my proper sphere to meddle with secular matters? Am I not, indeed, going into a sphere out of which I had better keep myself, and all over whom I may have influence? For is not science antagonistic to religion? and, if so, what has a clergyman to do, save to warn the young against it, instead of attracting them toward it?

First, as to meddling with secular matters. I grudge that epithet of secular to any matter whatsoever. But I do more; I deny it to any thing which God has made, even to the tiniest of insects, the most insignificant atom of dust. To those who believe in God, and try to see all things in God, the most minute natural phenomenon cannot be secular. It must be divine; I say, deliberately, divine; and I can use no less lofty word. The grain of dust is a thought of God; God's power made it; God's wisdom gave it whatsoever properties or qualities it may possess. God's providence has put it in the place where it is now, and has ordained that it should be in that place at that moment, by a train of causes and effects which reaches back to the very creation of the universe. The grain of dust can no more go from God's presence, or flee from God's Spirit, than you or I can do. If it go up to the physical heaven, and float (as it actually often does) far above the clouds, in those higher strata of the atmosphere which the aëronaut has never visited, whither the Alpine snow-peaks do not rise, even there it will be obeying physical laws which we hastily term laws of Nature, but which are really the laws of God; and if it go down into the physical abyss; if it be buried fathoms, miles, below the surface, and become an atom of some rock still in the process of consolidation, has it escaped from God, even in the bowels of the earth? Is it not there still obeying physical laws, of pressure, heat, crystallization, and so forth, which are laws of God—the will and mind of God concerning particles of matter? Only look at all created things in this light—look at them as what they are, the expressions of God's mind and will concerning this universe in which we live—"the voice of God," as Bacon says, "revealed in facts"—and then you will not fear physical science, for you will be sure that, the more you know of physical science, the

more you will know of the works and of the will of God. At least, you will be in harmony with the teaching of the Psalmist. "The heavens," says he, "declare the glory of God; and the firmament showeth his handiwork. There is neither speech nor language where their voices are not heard among them." So held the Psalmist concerning astronomy, the knowledge of the heavenly bodies; and what he says of sun and stars is true likewise of the flowers around our feet, of which the greatest Christian poet of modern times has said—

> "To me the meanest flower that grows may give
> Thoughts that do lie too deep for tears."

*Abstract from Good Words.*

## SIGHT AND THE VISUAL ORGAN,

By Dr. A. VON GRAEFE,

LATE PROFESSOR OF THE UNIVERSITY OF BERLIN.

BE the idea what it may, that we form to ourselves of the mysterious tie that links our *perception to the life of the soul*, so much is undoubted, that the material supplied by the impressions of the senses constitutes the basis on which the soul unfolds; further, that they furnish the nutriment on which our thoughts and conceptions live and grow, and that through them alone is preserved the connection between the invisible "I" and the external world—the soil in which all conscious intellectual activity strikes root.

The child does not come into the world *fitted out* with elementary notions, as the idealists have taught, but endowed with the capacity for *acquiring* these ideas. These impressions, coming to it through the senses, furnish the "intellectual fuel" for the first psychical processes. And, obviously for this embryo stage of mental life, the association of the senses of seeing and feeling is of peculiar importance. The richer the world of sensuous impressions is, and the more manifold the relations of sense to sense are, so all the more numerous and varied are our inductions from them. By means of a process of collecting and comparing, compound ideas are evolved out of simple ones, and the normal, logically organized mental life attains an ever-higher development, while, by the inexhaustible activity of the senses, it receives a never-failing supply of fresh material for the perfecting of its psychical structure.

The senses are indeed the gates to the mind, through which aliment passes for its sustenance; but equally, they are the portals through which science must endeavor to penetrate into the mental world. This has often been attempted, though in another manner, as by lay-

ing down postulates on the nature of the soul. But, since the beginning of the world, this manner of committing our thoughts to the guidance of metaphysical hypotheses has never increased our knowledge even by a hair's breadth.

Fortunately, the majority of thinkers have now struck into the more promising paths of observation and analysis. Essential and most important progress has been made in the knowledge of the human body, since men have ceased to indulge in subtle speculation into the nature of the principle of life, and turned with an undivided spirit of inquiry into the laws of organic appearances. And since men have applied themselves to trace with care the psychical manifestations of perception into the world of ideas, and to do the utmost in their power to discover the laws which there govern, there has arisen another science, forcing itself more and more on our notice as it daily proves itself to be possessed of an inherent vitality. I refer to the science of *psychology.*

Such being our starting-point, the operations of the perceptions acquire a wider significance. Resting on this increased significance, I now venture to bring before you the structure and functions of that organ which, from the enormous amount of material it is the means of bringing to the mind, takes a prominent place in the part assigned to the operation of the senses. If I succeed in heightening a little your interest in this organ, or even only in reanimating in some of you the sentiment of happiness which must fill every grateful child of the Creator, when, on awaking in the morning, he joyfully greets the light of day, I shall have earned a rich reward for a trifling exertion.

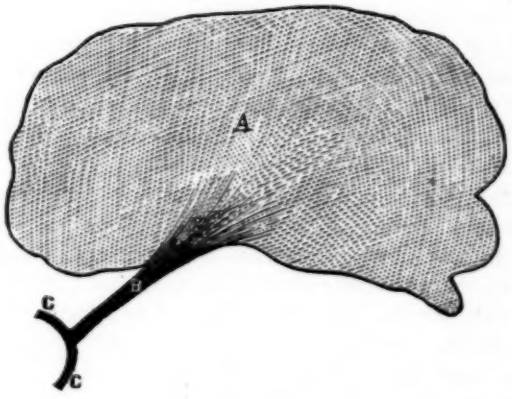
Suppose, as shown in Fig. 1, that the brain which reposes in the cavity of the cranium, and is the bodily organ of consciousness, runs off, at one spot of its complicated structure, into a *cord-like process*, which lengthens till it reaches the surface of our body, when it then spreads out again in an umbellar form. Imagine, further, this whole process, including its roots, endowed with a specific sensitiveness, by virtue of which it responds with a *luminous sensation* to every irritation applied, and you have a fundamental idea of the *nervous* part of the visual organ.

Before proceeding further, let us first become better acquainted with these parts. A, indicates the brain; B, the aforesaid process, or in other words the *optic nerve*, which, passing through an aperture in the cranium, stretches on till it reaches into the orbit, where it spreads out into that expanse C, which, under the well-known term of *retina*, turns its surface to the outer world. Lastly, X is the point where the process is inserted in the brain, the letter X meaning to indicate the still unknown extent of its connections.

When I said, above, that every point of the whole mechanism, on being irritated, produced a luminous sensation, I meant that the irritation was conducted to the brain, and called forth this sensation in that

sole source of conscious impressions. It is the same irritation coming in contact with the organ of consciousness, which we observe in the nerves of touch, with this difference that, in the above case, the *quality* of feeling differs; it is *luminous* or *colored.* The mere producing of this sensation of the luminous does not in any way depend on the *nature of the irritation.* Squeezing, pinching, pulling, chemical or electric irritations which give rise to the sensations of warmth or pain in a nerve of touch, call forth in the optic apparatus, by virtue of its specific sensitiveness, only a feeling of light, accompanied by neither pain nor heat.

FIG. 1.




A, Brain; B, Visual Nerve; C, Retina; X, Root of the Optic or Visual Nerve.

You ask how men have arrived at the knowledge of these things, seeing the mechanism in question is almost entirely removed from any direct investigation. First, then, the umbellar expansion of the optic nerve, the retina, enables us to make experiments; this retina being in such close contact with the eye, the optical part of the visual organ, that it is accessible to every sort of mechanical irritation. You have yourselves, consciously or unconsciously, often made such experiments, when you watched the circles and sparks of fire and light, which become visible on rubbing or pressing your eyes through their lids, or striking them with a hard substance. Here the eye, as an optical apparatus, remains passive. Just as a man, who sees, is aware of the phenomena even in the deepest darkness, so is also a blind man, as long as the retina is endowed with its specific sensitiveness or sensory power, by which it responds to every irritation with a luminous sensation. Even after blindness, this dancing of sparks of fire and light may be kept up by continual irritation in the eye to such a tormenting extent, that, in order to prevent it, we usually cut the optic nerve just behind the eye, when the sparkling and scintillating cease.

Although less directly, the optic nerve, as well as the retina, is accessible to our observation. Hence we ascribe certain scintillations, visible to us in a rapid motion of the eye, to a twist of the nerve; surgical operations, dating from a period when narcotics were not employed, have likewise shown that contact with this nervous cord produces only sensations of light, not those of pain.

Lastly, we can point out the seat of the root, or the central termination of the optic nerve, by anatomically tracing the fibrils of the visual nerve into this tract; and partly, too, by an analysis of the phenomena observable in healthy and diseased states. When the brain has been excited by a narcotic, and the irritation is transmitted to the aforesaid tract, there arise sensations of light, which, combining with ideas of luminous objects, simultaneously excited, are transformed into what we call phantasms. The same thing takes place when the blood, as in fever, heats the brain; or when that part of the organ is excited from other causes. And thus it is with our visual impressions during dreams, or even in a half-waking condition.

But all this does not constitute any relation between sensation and the objects of the external world; that is, proper *sensory action*, whether it be the gay visions that surround us in the intoxication caused by opium; the comic phantasmagoria that hashish conjures up; the compact shapes that belladonna brings so near us; the airy forms seen in our dreams, or the scintillations produced by pressure, they all proceed from irritation of the special sensory power, and it is indifferent to the brain whether it receives its impressions from direct vision, or only from internal influences. All those operations, therefore, which proceed from direct irritation of the nervous part of the visual organ, *without the medium of the eye and of light*, under the term *subjective vision*, are opposed to those phenomena produced by the media of eye and light, and known as *objective vision*.

Great as are the influences of this subjective sight for the refreshment of our brain during sleep, and powerfully as they affect the temperament of the blind, they cannot connect us with the outer world. The yellow light which floods our field of vision, on rubbing the retina, is of no use to light up external objects. Hence, when, some years ago, a man pretended to recognize a delinquent who had attacked him in the night, by the sparks of fire produced by a blow on his eye, and founded an accusation thereon, it was, of course, unjustifiable, although the authorities consulted did not declare against the impossibility of the fact.—Baron Münchausen went still further in the use to which he put those visual sparks; for, when attacked by bears in the night, he not only struck out light enough by which to prosecute the chase, but fire, too, for his guns with the same blow.

We cannot entirely overlook the question whether sensations of light can be produced with the assistance of any other mechanism in the body but that of the visual nerve. As only the part where sensa

tion originates is endowed with specific sensory action, so the irritation of that part can alone produce impressions of vision; but this irritation may be imparted to it by other parts of the brain, or by other nerves. It has been already stated that irritations of the brain produced by narcotics are transmitted only by proximity to the terminal extremity of the optic nerve. At the same time, it may be that the irritation proceeds from another nerve, from a nerve of touch or of hearing, and, penetrating to the brain, affects it so strongly as to send on the concussion to the optic centre. It is this that takes place when, after having listened to disagreeable sounds, you are seized with certain sensations in the nerves of touch, for instance, in those of the teeth; or, heving gazed into the bright light, you become aware of a tickling sensation in the nose, causing you to sneeze. In a word, it is here a question of so-called *sympathy*, to be explained by transmission of the irritation from one nerve to the other.

The disposition to such sympathetic sensation is increased by a general irritability of the nervous system; while, in a calmer state of the nerves, the excitations run more regularly in the paths directly affected by the originating causes. In this manner, those indirectly-provoked visual impressions which preponderate in circumstances of sickness and disease are augmented.

In these indirect visual sensations, as in the direct excitation of the mechanism of the visual nerve, only subjective sight has been treated of, cut off from from every relation with the outer world. We are quite ready to attach credit to the fact that, at exhibitions of somnambulism, when the natural irritability of nervously-disposed individuals is heightened, subjective visual impressions are produced in an unusual degree. Should, however, any connection with surrounding objects be founded on these results, or any transmission of the specific sensory action into other parts, as, for instance, transmitting to the skin of the abdomen the power of producing objective visual perceptions, such as are necessary for reading, these assurances are to be ranged in the same category of physiological blunders as the Münchausen hunting-story.

By what means, then, does the mechanism of the visual nerve, which we have hitherto regarded merely as the instrument of subjective sight, become a practical bridge between our ideas and the outer world, and a medium of the true and accredited *operation of the senses?* I answer, by a normal relation to a definite irritation proceeding from an object. This, which we might call the *adequate sensory irritation*, is *light.*

Let us consider the general relation between light and the organ of sight. Unable to discover with certainty the nature of light, it is explained in physics as being the undulating motion of an elastic body called ether, diffused throughout the universe. According to this, the irritation by light represents the shock of the undulations of ether on

the irritable nervous matter, and at once takes its place among the mechanical excitations mentioned above when speaking of subjective sight.

The cord of the optic nerve is insensible to the undulations of the ether; the peripheral expansion of the retina is alone susceptible of irritation by light. This peculiarity has to do with the arrangement called the *terminal apparatus*, with which it is now proved every nerve is furnished. The *nervous cords* themselves are preëminently conductors; their irritation, when it does take place, necessarily produces impressions which come under the head of qualitative, for the eye, therefore, of the quality of luminous sensations; those impressions do not, however, stand in any closer relation to the adequate sensory irritation, and may be, as far as we are concerned, quite devoid of sensitiveness.

According to physics, light is the same species of motion in the ether as warmth; only, in order to affect the retina, the undulations must take place within certain limits of rapidity. Relatively they possess the greatest velocity in the violet-colored part of the spectrum, and the least in the red. In the same proportion as the velocity of the undulations diminishes, does light become invisible, and only dark rays of warmth are emitted, while on its being more highly heated, from the increased rapidity of the undulations, it reaches the glowing-point, that is, it emits rays of red light.

From this we see that the idea of light depends essentially on the organization of the retina. Were it different from what it is, did it possess any susceptibility for ethereal vibrations of a less degree of velocity than those at the red end of the spectrum, then we should call *that* light which we now term a dark warmth.

In certain cases of natural color-blindness, the susceptibility of irritation in the retina is quite undeveloped for the extremest red of the spectrum.

Now, while the light coming from external objects irritates the retina variously according to its color and power, the impressions made by luminous objects are also very various, and herein lies the first link of connection with the outer world.

It is only the visual organs of the lower animals which lose themselves in such a general and vague relation to the surrounding ocean of light and color. The organ which now occupies our attention has a far higher design to serve, viz., to awaken a perception of separate objects, and of their peculiar forms and colors. Were the retina as you see it in Fig. 1, a surface curving outward, then such a design could not be fulfilled; for every part would receive light from all the points of the outside world. In order to fulfil this condition, every individual point of the retina must enter into a separate and individual relation with the light proceeding from a point beyond it; nor till this takes

place can the irritation of each separate spot of the retina produce a peculiar impression corresponding to the presence of the object-point; in short, according to the optical expression for such a relation, *a picture of the outside world* must be painted on the retina.

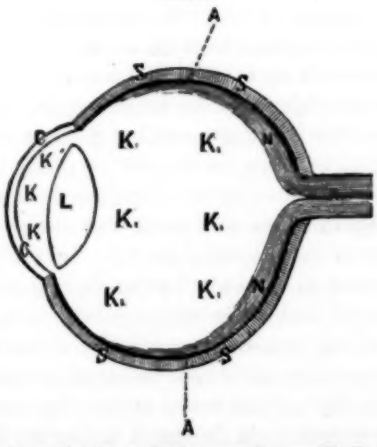
And this is indeed what takes place. As, on the one hand, the retina stands as the terminal apparatus of the optic nerve; on the other hand, it acts as a shade subservient to optical purposes; a screen, on which a perspective picture of the outside world is projected. If you compare it with the dull glass on which the picture in the *camera-obscura* falls, or the prepared plate in the photographer's camera, you have a correct notion of what I mean. As, in the photographer's camera, the picture falls on the sensitive plate, and is impressed on it by means of chemical changes produced by light, so in the eye it falls on the sensitive plate of the retina, whose irritations are telegraphed to the brain in due form.

We henceforth have to consider this *image painted on the retina* as the real object of the *operations of the senses.*

But how does the picture imprint itself on the retina? This is done by an optical apparatus close behind the retina and in connection with it; and, in short, by means of that mechanism known to us as the *eye.*

If we compare the retina with the sensitive plate in a camera-obscura, we shall perceive that the eye has indeed an undeniable resemblance with this well-known optical instrument, the camera-obscura.

FIG. 2.




S, Sclerotic; C, Cornea; L, Crystalline Lens; K, Aqueous Humor; K', Vitreous Humor; A, Choroid; N, Optic Nerve and Retina.

This is essentially a box painted black in the inside, with an opening fitted with a collective lens, turned on the objects of the outside world, and which receives the images produced by this lens on the wall behind. In order to show us the image, the one side of the box

is replaced by a dim plate of glass. Now cast a glance at Fig. 2; and first suppose the box to be round; next, instead of the wooden wall, an organic tissue; and the window glazed with a transparent organic coat or tunic, instead of with a crystal lens, and which fulfills the same purpose as a collective lens, and strengthened by one or more lenses placed one behind the other. Further, suppose, instead of the blackened inside of the walls of the box, the organic sclerotic coat overlaid from the inside by a second dark-colored tissue; and, lastly, the retina at the farther end as sensitive plate, and you have certainly an imperfect, but still, as far as an outline goes, a good general idea of the chief parts of the eye.

To the clearer understanding of these parts, the figure is provided with letters.

The tissue marked at the different sections with an S, is the enveloping tissue called the *sclerotic* or sclerotic coat.

To the front, overlapped by the above, lies the transparent tissue, the *cornea*, C, which represents the window, and at the same time contributes essentially to collecting the rays of light. At the back enters the optic nerve, which, spreading out to right and left within the sclerotic, receives the name retina, likewise marked with an N.

The chief business of the *lens*, L, lying well back, and rendered perfect by the humors (K, aqueous, K′, vitreous), which fill the spaces or chambers, is the refraction of the rays, whose admission has already been prepared by the cornea.

And, lastly, overlying the interior surface of the sclerotic, is the *choroid* with its pigment, being the substitute for the black paint in the camera. You find it marked with an A.

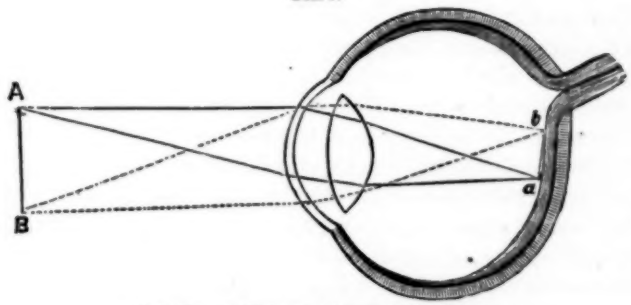
Now, if this eye with its cornea, like a camera-obscura with its window, is turned on the objects of the outer world, we shall behold what Fig. 3 shows us: The light proceeding from a point A, beyond the eye, throws a pencil of rays on the cornea; this is already refracted here and there on the surface of the lens, but in a manner so as to collect all its rays again in the one point *a* of the retina. This *a*, then, is the image-point of the object-point A. In the same manner, *b* becomes the image-point of the object-point B, and all the object-points between A and B will find their image-points on the retina between *a* and *b*. In a word, an *inverted perspective* image of all the objects comprehended in the space A B will be found reflected on the retina.

Let us now examine a little more closely the structure of the eye, together with the object it is designed to serve, taking the separate parts in the direction from without inward.

The *sclerotic*, a stout and not very elastic coat, wants no further description. On the other hand, however, the *cornea*, as the transparent window, deserves your whole attention. In the construction of the cornea Nature has had to overcome exceptional difficulties. If you remember how apt every organic body exposed to the air is to fall a

prey to desiccation, under the influence of which the optical homogeneousness, on which transparency depends, is lost, you will readily acknowledge the amount of resistance the cornea is enabled to offer. But further, consider that the cornea does not possess a homogeneous structure, but consists of five different, partly compound layers; that it hides in its interior numerous cellular bodies, canals for the passage of the humors, and a net-work of nerves—and then assuredly you will not refuse your admiration to the optical excellence of this most indispensable of all windows.

FIG. 8.




A B, Object of Sight; *a b*, Image on the Retina.

However, the difficult task implied in the structure of the cornea could not be fulfilled without the aid of some extraneous appliances. Thus, two movable covers lie over the eye, namely, the *eyelids*, whose inner surface is a compound *humorous matter*,[1] a brackish, mucilaginous, fatty solution. After having used our eye for a while, there arises a certain sensation of dryness on the cornea, from exposure to the air; the ever-recurring necessity of renewing the moistness causes us to close the lids, or, as we say, to *wink*. This is at least the chief design of the dropping of the lids, which besides lend their aid to the periodical exclusion of the irritation of the sight, as in sleep, for defence against the dazzling light, and for protection against the impurities in the atmosphere. The cornea is likewise being continually moistened by the posterior humors. But, with all the expedients and appliances used by Nature, perfect transparency cannot be always preserved: dull spots are formed on the window of the cornea, often causing derangement of vision. Unimportant irritations, which on the surface of the body are not noticed, seriously affect the cornea.

Let us now notice the second coat, the *choroid*. This we compared to the black coating of paint in the camera-obscura. Thinking of the dazzling and delusive visions which are a consequence of the gradual consuming away of the pigment in the choroid, or which accompany the entire want of it, as with the albinos, we cannot doubt that one

[1] This matter receives the name of *mixed tears*, contrary to the *briny tears*, which, by mechanic irritation or during weeping, flow from the eye.

essential design of this tissue is to intercept the scattered rays. But, apart from its office of conducting nourishment to the eye, and secreting the humors by means of its numerous blood-vessels, the choroid has a *second optical* design to fulfil, which now brings us to the characteristic signs of the eye.

As you will perceive from Fig. 4, which gives a section of an eye from life, the choroid, after having accompanied the sclerotic to the edge of the cornea, goes on expanding anteriorly, and from henceforth bears another name, that of the *iris*, or, as we might say, the *rainbow tissue*. As this process, which likewise contains a quantity of pigment, lies behind the transparent cornea, it can be observed in all its minutiæ; and, on account of the rayed arrangement adopted by its fibres, it is frequently called the eyeball, or star. The iris is broken in the centre by an opening to which we apply the term *pupil*, being the *visual aperture*. It usually seems to be black.

The presence of the iris greatly diminishes the extent of surface designed for the reception of light; the whole pencil of rays that falls on the cornea, as supposed, in Fig. 3, not reaching the retina, but only as shown in Fig. 4, on that section of it which enters the pupil. Though much of the volume of light is thereby lost, the restriction is highly beneficial, by sharpening the image on the retina; for the refraction of the rays is much more equal in the centre than toward the margin.

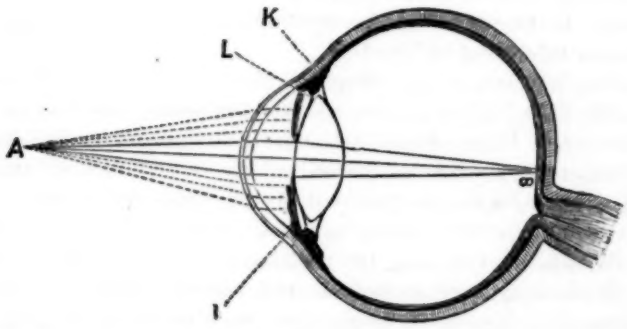
The iris, however, has a still more important function to perform. It *regulates the entrance of the light*, being furnished with a muscular apparatus (ciliary muscle), which provides that in strong light the pupil contracts, and in duller light expands. Thus the iris plays the part of a so-called movable diaphragm, a common appliance in optical instruments, used to dull the light for the purpose of seeing better. You cannot but have observed this play of the pupil, and how it accommodates itself to the volume of light; nor can you be ignorant that the iris with its varied coloring from light blue to deepest brown is what we know as the color of the eye. It is perhaps less well known to you, however, that the peculiar pigment required for the darker colors of the iris comes only as we advance in life, and that, therefore, we all commence our earthly course with blue eyes; a fact already known to Aristotle.

The *crystalline lens*, which is held fast in its place by a very fine tissue, as shown in Fig. 4, from the curve of its surface, and its strong power of refraction, plays an important part by conducting the collected light to the picture on the retina. It has, however, another and extremely important design, which must here be carefully considered.

The requirements made on an optical instrument depending on lenticular effect, are different according as it is expected to project images of nearer or more distant objects. The light with very divergent rays, and proceeding from near objects, is collected to a picture

behind the lens, while that of the distant objects falls with almost parallel lines. To return to the camera-obscura, you must draw out the tube with the lens, in other words, remove the latter farther from the intercepting plate if nearer objects are to be impressed, and on the other, push it in, if more distant ones are wanted. The same effects might be produced at equally the same distance by simply substituting lenses of different power. Now, the human eye has to fulfil the requirement of projecting clearly-defined images on the retina, whether they are but a few inches off, or at an immeasurable distance. The eye being strictly subject to lenticular laws, either the space between the lens and the retina must have the power of varying, or the lens itself, by a change of form, must exercise now a stronger now a weaker power of refraction.

FIG. 4.




The same parts as in Fig. 2, besides: I, Iris; K, Ciliary Muscle; L, Suspensory Ligament of the lens (zonula).

The conclusion has now been arrived at, that this power of accommodation depends on a *varying curve of the lens.*[1]

In order to effect this, a great degree of *elasticity*, chiefly of the outer capsule, was obviously necessary, and we find this requisite complied with by an admirably delicate structure of concentric layers, according to which its density reaches the minimum at the periphery of the lens, while its aggregate power of refraction is increased, as if it were composed entirely of the strong refracting substance of which the centre consists.

As the power of accommodating its focus rests on this quality of the lens, it is necessarily accompanied by a loss of elasticity with increasing age. The eye of a man of sixty, that sees distinctly at a dis-

[1] The mode of procedure is now known down to the last and most minute detail. The surfaces of the lens give back extremely delicate reflections, which with the proper aids may be measured in the living eye, and from the size of which the curve may be calculated as in convex and concave mirrors. As auxiliary of this change of form, there is a peculiar agent—a muscle embedded in the choroid (K, Fig. 4)—which has the power of contracting and expanding the suspensory ligament of the lens.

tance, is unable to distinguish an object five inches off; and, if, against all rule, it see sharply at five inches off, this benefit is counteracted by the inconvenience of seeing distant objects with great indistinctness. The gradual hardening of the lens is accompanied by a decrease of power of adjusting its focus, and is even subject to such small individual fluctuations that, by an exact calculation of its play,[1] we may sometimes arrive at the most indiscreet conclusions respecting the age.

Should the lenticular elasticity no longer admit of a sufficient scope for refraction, we must then either adjust the distance of the objects, as we see a far-sighted individual do, by holding the book proportionably farther off, or we must afford the eye assistance by accommodating it with movable auxiliary lenses, *spectacles*, which replace the lost power of adjusting forms to the natural eye. This power of accommodating the focus disappears beyond recall if the lens has sustained an injury, or if we remove it entirely, from its having grown turbid. This takes place in the operation for *cataract*, which is a dimming of the sight from a thickening of the lens.

The lens, however, is not altogether free from optical irregularities, as when the focus of the eye has not been perfectly adjusted for seeing in the distance. Those of you who are short-sighted, on looking at a distant street-lamp, perceive, instead of the clearly-defined image, an irregular circle of light, and you will at the same time observe within that circle a number of peculiar rays and dots, which are nothing but irregularities in the lens, i. e., the reaction of those irregularities on the retina. Even an eye whose sight is quite normal, makes an analogous observation if it directs its gaze to a very fine point of light, as, for example, to a star. Both the star and the atmosphere are equally innocent of the small beams that radiate from it; they are the rays of our own lens which we transplant to heaven. So little aware are we of what takes place in the depth of our sensory organs, or in the immeasurable distances of the universe.

The spaces between the lens and the cornea, as also between the lens and the retina, are filled with a liquid medium, called *humors;* the latter, which constitutes by far the largest chamber of the eye, is filled with a gelatinous substance called the *vitreous humor.* This medium likewise contributes essentially to the concentration of the rays of light, as, lying between two curved partitions, they exercise a similar influence as the lens.

The vitreous humor, optically speaking, is, however, not pure; small granular or wavy forms, which all of you at times have seen hovering within your field of view, and which pursues so many hypochondriacal persons on their summer trip to a watering-place, are occasioned by shadows thrown on the retina by a partial, delicate opaqueness in the vitreous humor. Those bodies are so light as only to be

[1] The diminution of the play does not commence in the second period of our lives, but, as Donders has proved, in a regular manner from childhood onward.

perceptible, either in certain effects of light, or on a peculiar exertion in the straining of the attention. By a simple experiment it is possible to make every person acquainted with these guests of his field of view, the so-called *muscæ volitantes;* only, one must be prepared for those formerly overlooked, but once honored with attention, never again stirring from their post.

In order, likewise, to preserve space for the play of these variations in the form of the lens, in the act of adjustment, it was necessary to surround the lens with a liquid or elastic medium. That the aqueous humor bears a part in moistening the cornea, has already been stated, but in the voluminous vitreous humor we behold the *regulator of the shape and tension* of the eye. Such an auxiliary medium is of urgent necessity to keep up the regularity of refraction, the quality of tension in the retina as a sensitive surface, and the action of the optic nerve. Some years ago, I was happy in being able to demonstrate that a comprehensive range of diseased conditions and also blindness, the causes of which had been successively sought for in different parts of the eye, simply arose from too great a tension being exercised by the vitreous humor—a discovery which imparted so much the more pleasure, as a suitable remedy was likewise at hand.

Let us imprint on our memories, from the model of a magnified eye, the positions and dimensions of the different parts. For the present, I begin with the cord of the optic nerve, which, as you perceive, does not enter the sclerotica exactly opposite to the cornea. This part, as well as the larger posterior chamber of the eye, is embedded in the orbit, and is therefore not visible externally; while, on the other hand, between the lids, you remark the white of the eye, which is the anterior chamber of the choroid; next the transparent cornea; and away through it the colored iris, with the pupil in the centre.

The black appearance of the latter used to be ascribed solely to the dark layer formed by the choroid for the interior of the eye, absorbing all the light. More patient and minute investigations have, however, proved that the pupil derives its blackness only partially from the above circumstance, and mostly from the refraction of the light. Helmholtz has succeeded in banishing that darkness from the pupil of the human eye. By a simple arrangement, called the *speculum oculi*, he uses the light which is reflected from the deeper parts of the eye to illuminate the whole of the interior, as also the image itself projected on the retina. This invention exercises an influence not only on the peculiar branch of the oculist, but likewise on the broad field of medical investigation, seeing it affords an insight into the optic nerve, a direct process of the brain, and other structures, which, along with their analogies, were hidden from observation in the body.

The dimensions of the eyeball among strong-sighted individuals is more equal than you perhaps imagine. The apparent differences of size lie almost exclusively in the shape of the slit of the lid. If it has

a wide slit, it affords a view over a greater part of the eyeball, and we think it bigger, simply because we see more of it. In the same manner, our judgment is deluded by the different degrees of prominence of the eye. A staring or protruding eye impresses us as being larger, although it is only pressed forward; while in advanced age, or in consuming sickness, the sunken eye is thought smaller.

If the eye really is larger, then the distance between the cornea and the lens will be greater; and if the effects of the refracted light remain the same in the latter, the image will no longer be projected on the cornea, but in front of it. And this is what really takes place in that wide-spread malady called *short-sightedness*. Here we have especially to note that the mean axis of the eye is too long. There are others called *far-sighted* eyes, whose visual axis is too short, the image for such eyes falling behind the retina. In order to reëstablish the conditions of keen vision in both cases, the effects of refraction must be diminished for the short-sighted, by diverging or concave glasses; for the far-sighted, by collective or convex glasses. Those conditions have nothing to do with the want of the power of adjustment of focus. If you correct the defective construction of the short-sighted eye with a concave glass, and that of a far-sighted with a convex one, the lens —its mobility being preserved—can with their aid accommodate itself to near and distant objects, which neither an old man, deprived altogether of the power of adjustment, nor an individual who has been operated on for the cataract, is capable of doing.

Let us now pursue the analysis of the model in the same order as at the outset. First, then, fold back the cornea with the anterior section of the sclerotica; the margin of the eye to the front is now interrupted by the pupil, and is for the rest formed by the tissue of the iris, and the anterior section of the choroid. The space (at present wanting) in front of the iris-curtain was filled with aqueous humor, which you are to suppose has escaped. Let us now remove the posterior half of the tissue of the visual nerve; the whole eye will then be closed up by the passage of the choroid and iris, which now meets with no break, except anteriorly from the pupil, and posteriorly from the entrance of the optic nerve. If, now, as with the sclerotica, we fold back the anterior division of the choroid along with the iris, in doing which we have an opportunity of convincing ourselves of the true nature of the pupil, and that it is indeed an opening, we then come upon the hard lens lying behind. Taking this away, as also the gelatinous vitreous humor, we at length remove the posterior section of the choroid, and have nothing left but the optic nerve and the retina. Thus we have again arrived at the starting-point of our reflections; and it only now remains for me to bring before you the retina.

Before, however, entering on this division of my subject, let me call your attention to a few fundamental processes in the act of seeing. First, the picture or image on the retina is perfectly sharp only at one

particular spot, situated somewhat beyond the optic nerve and exactly opposite the centre of the cornea. The light which falls along the main axis of the eye converges at this point. This spot in the retina is marked by a small *hollow*. For the rest, it is filled up with a structure of its own; and we have reason for assuming that it furnishes the most exact perceptions, not only on account of the greater optical sharpness of the image, but also on account of the higher energy or activity with which it is endowed. It is this spot we make use of when we desire to go into details; for, if we wish to examine closely into the nature of an object, either we approach it to the eye, or bring the eye to bear on the object; but, in both cases, in such a manner as to cause the image to fall exactly on the hollow of the retina, or on the spot of *direct vision*. This arranging of a position for an object is what we mean when we speak of adjusting the eye.

The images which are not projected on the spot of direct vision are not sharp; for the necessary light falls on the refracting media more or less obliquely. This, and the decrease in the activity of the sight from the hollow to the sides, explain how the objects, the farther they are removed from the fixed point, appear with so much less clearness and sharpness of outline. *Indirect* or *eccentric* vision, as it is termed, makes us aware simply of the presence of objects, by giving us some notion of their shapes; but we are unable to distinguish even the biggest letters, if the image of them should fall only one hair's breadth off that one spot in the retina. In reading, the eye must constantly move onward to the end of the line, the single letters thus gradually imprinting themselves on the direct point of vision. On the other hand, indirect vision offers hints for fixing the object in our eye; it warns us of, and prepares us for, the object previous to our devoting our whole attention to it, and it is further of use in procuring a *wide survey*, by enabling us to see and examine what lies before us. There are some who only possess direct vision. Any one can put himself in the place of an individual so afflicted, by holding a long tube of small calibre to his eye. You naturally distinguish the most minute objects enclosed within the restricted range of vision; but, deprived of the lateral impressions, you could not guide your steps in the street. In short, you must fancy the image of the external world that is imprinted on the retina, like a picture *highly finished in the middle*, and only *roughly sketched out at the sides*.

The distance from the spot of direct vision, at which the objects may be perceived by eccentric vision, has its limits. When looking straight before you, you can just perceive a hand which stretches down the whole length of the face, in the direction of the temples. This is the extremest point from which it is possible for light to fall on the retina; but, if you attempt to go beyond it, the hand disappears, its image not being projected on the retina. The combination of all the extreme points from which, with a set eye, impressions may be received,

forms the frame of the field of view, and what is within this frame is itself the *field of view.*

This space, immovable as regards the head, becomes the arena to which both those excitations produced by the senses, and those belonging to subjective sight, are transposed; and this transposition always takes place in the same direction as that in which a regular act of sight would in any case lie. Although long experience has taught us it is a delusion, still we always place the image projected by a mirror behind it, because the reflected light falls into our eye just as if the object were behind it. But the sparks produced by pressing the eye from the side of the temples, we seem to see in the opposite side of the field of view; but we do so because, in the normal act of sight, the retina is irritated (from the side of the temples) by light falling from the opposite side. By the *action of projection*, the reversed image naturally regains its upright position in the field of view.

A general irritation of the retina unaccompanied by a perception of objects will give us a *light* field of view, and, on the other hand, a perfect repose of those parts will give us a *dark* field of view. The former represents the sense of the repose of a mechanism endowed with the power of action; the latter corresponds to the absence of all mechanism whatever. The *feeling of darkness*, therefore, results merely from the expansion of your field of view as opposed to your retina, if I may so say; while behind your back you have the feeling neither of light nor of darkness; you simply miss all sensation of light.

Touching the *size of the images on the retina*, as compared with the objects themselves, I need merely remind you of the rules of perspective. The images on the retina stand in reversed proportion to the distance of the objects. The image of a pencil, held a foot from your eye, covers the trunk of the tree before your window; that of a pea, at a like distance, covers the moon in the sky. If, notwithstanding, we think the moon bigger than the pea, and the tree than the pencil, the reason is that, apart from our being well acquainted with the tree, our judgment is a combination of the size of the image on the retina and the distance of the object. Now, as consciousness is for the most part founded on experience, so just and correct *perspective sight* is in the main something we *acquire.* A child will assuredly not appreciate the difference between the pencil and the trunk of the tree in the same degree as an individual who by experience has learned to know the value of his impressions. What the child first knows of the moon is, that he cannot reach it with his hand; "But," as I once heard a child say, "mother can reach it down." Other inferences have helped him to this conclusion. We are so accustomed to merely play with children, that we are easily blinded to the full seriousness of such requests.

We cannot break off these reflections on the image of the retina without making mention of a remarkable spot in the background of

the eye—the yellow spot marking the entrance of the optic nerve. All perception whatever is arrested within the bounds of this spot—it is a *blind* point in our field of view.

The *blind spot* is by no means so excessively small. At the distance of four paces, it would cover a man's head in the centre of your field of view; and almost a hundred moons in the sky would find room within its bounds. When Mariotte made this important discovery, it caused so much commotion that the experiment had to be repeated before the King of England in 1688. In the endless variations of the experiment, the remarkable fact only received a new confirmation. For the rest, this discovery had almost proved fatal to the doctrine of perception; for, as at that time the optic nerve and the retina being considered as essentially the same, one might deduce, *a priori*, the inference that, just at that point of entrance at which all the conducting fibrils converged, a heightened sensibility might be argued. But, now proving to be insensitive, the retina itself could no longer be regarded as the regular conductor of the sensation of light. And this was the conclusion to which Mariotte did arrive, transferring the sensibility to the choroid behind the retina, till at length Bernoulli and Haller again restored it to its rights.

This apparent enigma is explained by what I told you of the general relation of light to the visual organ. The part the optic nerve plays is only that of a conductor, while the sensations of the vibrations of the ether, as also of the specific sensory irritation, is committed to the retina, or, more correctly speaking, to its external layer.

Another question is, Why does the existence of the blind spot usually escape our attention? The chief reason is that, as the gap is regularly situated in the same spot in the field of view, the *idea* has learned to fill it up in the most natural manner, and as is suitable for the connection of objects. For instance, I draw the figure of a cross on the board, and fix my eye on it, so as to cause the centre of this figure enclosing the point of intersection to fall on the blind spot; in this manner I believe indeed that I see a cross, while in reality I only see what lies beyond; fancy supplementing the rest. The cross is a commonly-known figure, and when any two lines take a perpendicular direction toward each other, they as a rule really do intersect each other. The best proof of this being the case is that, when you obliterate all that lies within the district, you still continue to see the cross; and, to make the experiment more elegant, if you place some photograph in the empty space, you do not perceive it, you still continue to see only the cross. You have here, then, a conjunction of objective sensory action and subjective influence, apparently with the help of the central extremity of the optic nerve, which is highly significant for the whole doctrine, and which to a certain degree combines what I have been endeavoring to explain to you on both of those branches of the subject.

# ON THE DISCOVERY OF THE ELEMENTS.[1]

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THE word "element" is used by chemists in a peculiar and very limited sense. In calling certain bodies elements, there is no intention on the part of chemists to assert the undecomposable nature or essence of the bodies so called. There is not even an intention on their part to assert that these bodies may not suffer decomposition in certain of the processes to which they are occasionally subjected, but only to assert that they have not hitherto been proved to suffer decomposition; or, in other words, to assert that their observed behavior, under all the different modes of treatment to which they have been exposed, is consistent with the hypothesis of their not having undergone decomposition.

The entire matter of the earth, then, so far as chemists are yet acquainted with it, is composed of some 63 different sorts of matter that are spoken of as elementary; not because they are conceived to be in their essence primitive or elementary, but because, neither in the course of Nature nor in the processes of art, have they been observed to suffer decomposition. No one of them has ever been observed to suffer the loss of any substance different from the substance of its entirety. Thus chemists are incapable of taking away from iron, for example, a something that is not iron; or of taking away from it any thing whatever, so as to leave a residue that is not iron; whereas they are capable of taking away from iron-pyrites a something which is not iron-pyrites but is sulphur, so as to leave a residue which is not iron-pyrites but is metallic iron.

The notion of all other material bodies being constituted of, and decomposable into, a limited number of elementary bodies, which could not themselves be proved to suffer decomposition or mutual transformation under any circumstances whatever, but could, on the contrary, be traced respectively through entire series of combinations, and be extracted at will from each member of the series, is a notion which, undergoing in course of time a gradual development, was first put forward in a definite form by Lavoisier; until whose time, some residue of the great alchemical doctrine of the essential transmutability of all things—that the substance of all things was the same, while the form above was different—still prevailed. To Lavoisier is due the enunciation of the principle—departed from, however, in a few instances by himself—that all bodies which cannot be proved to be compounded, are in practical effect, if not in absolute fact, elementary, and are to be dealt with accordingly.

[1] Lecture before the Royal Institution.

Of the many definite substances known to chemists before the discovery of hydrogen gas, the following were afterward recognized by Lavoisier and his colleagues as elementary: First, the seven metals known to the ancients, namely, gold, silver, mercury, copper, iron, tin, and lead, distinguished respectively by the signs of the sun, moon, and planets; and each conceived to have some mystic connection with the particular orb or planet of which it bore the sign, and not unfrequently the name. Then three metals which became known at the latter end of the fifteenth or beginning of the sixteenth century, namely, antimony, discovered by Basil Valentine in 1490; bismuth, mentioned by Agricola, 1530; and zinc, mentioned by Paracelsus, obiit 1541. An elementary character was also assigned to the non-metals carbon and sulphur, which had been known from the earliest times; to phosphorus, discovered by Brandt, of Hamburg, in 1669; and to boracic acid, now known to be a hydrated oxide of boron, first discovered by Homberg in 1702, and still occasionally spoken of as Homberg's sedative salt. The list was further swollen by four metals which, in Lavoisier's time, had been but recently discovered, namely, cobalt and arsenic, identified simultaneously in 1733 by George Brandt, of Stockholm; platinum, discovered in 1741 by Woods, assay-master at Jamaica; and nickel, discovered in 1751 by Cronstedt.

The only other bodies known before 1766, and afterward included in the class of elements, namely, the alkalies and earths, had during the quarter of a century immediately preceding been made the subjects of especial study. The differentiation of potash from soda, both previously known by the common name of alkali, was indicated by Duhamel in 1736, and more completely established by Marggraf in 1758. The differentiation from one another of lime or calcareous earth, silex or vitrefiable earth, alumina or argillaceous earth, and magnesia or bitter earth, was accomplished by the labor of many chemists, more particularly Marggraf, Bergmann, and Scheele; prior to whose researches, silex, alumina, and magnesia, together with their different combinations and commixtures with each other and with lime, were held to be but impure varieties of lime. The nature of the difference between the caustic alkalies and earths and their respective carbonates was made known by Black in 1756; while the real constitution of the alkalies and earths, as metallic oxides, though suspected by Lavoisier, was not established until the beginning of the present century, by Davy and his contemporaries and followers.

The successive recognition of the elementary gases, quickly following Black's remarkable discovery of carbonic-acid gas, began with the identification of hydrogen by Cavendish in 1766. This was succeeded by the discovery of nitrogen by Rutherford in 1772; of chlorine and fluoric acid, the latter now held to be a fluoride of hydrogen, by Scheele in 1774; and of oxygen by Priestley in the same year.

Thus prior to the discovery of the first of the elementary gases, 23

kinds of solid matter, and one liquid body, mercury, were known, which afterward became recognized as elements. Between then and the present time, 33 kinds of solid matter, and one liquid body, bromine, have been added to the list—the discovery of the earliest of them occurring almost simultaneously with, or even just preceding, that of the last discovered of the elementary gases.

Among the number of bodies discovered prior to 1803, when Davy effected the decomposition of the alkalies, several, at first thought to be elementary, are now known to be compounds of oxygen with other bodies still regarded as elements; and conversely, two bodies, namely, chlorine and fluorine, at one time thought to be oxides, have since become regarded as elementary; but in none of these cases did the discovery of what is now considered to be the real constitution of the bodies add or subtract an element to or from the list.

From the period of the modern or Lavoiserian conception of elements and compounds down to the beginning of the nineteenth century, the recognition of new elements occurred with much frequency at short but varied intervals. After then, the discoveries became somewhat less frequent; but, even within the last 50 years, no fewer than 12 new elements have been added to the list, being at the rate of one new element every four years. Throughout, the periods of discovery have been somewhat irregular in their occurrence. Thus, in the years 1802 and 1803, six new elements were discovered, namely, tantalum, cerium, palladium, rhodium, iridium, and osmium; within the succeeding 14 years only one new element, but that a very important one, namely, iodine; and in the fifteenth and sixteenth years, three new elements, namely, lithium, selenium, and cadmium. The longest barren interval, one of 13 years' duration, took place between the discovery of niobium, by Rose, in 1846, and that of cæsium and rubidium, by Bunsen, in 1859. The last discovered of the elements, namely, indium, being fully seven years old, and there being no reason to consider our present list as any thing like complete, or to apprehend any cessation of additions thereto, it is now quite time for some other new element to be made known. For we may reasonably anticipate the discovery of new elements to take place at irregular intervals possibly for centuries to come, and our list of the elements to be increased at least as much in the future as in the past.

The fresh discovery, however, of any abundant elementary constituent of the earth's crust would seem scarcely now to be expected, seeing that of the 32 elements which have become known since the year 1774—the year of the discovery of chlorine and oxygen and manganese and baryta—the great majority belong to the class of chemical curiosities; while even the four or five most abundant of the since discovered elements are found to enjoy but a sparing, although wide distribution in Nature, as is the case, for example, with bromine and iodine; or else to be concentrated but in a few specially-localized

minerals, as is the case, for example, with strontium and chromium, and tungsten. Of course it is difficult to appraise the relative abundance in Nature of different elements; more especially from the circumstance of those which are put to commercial uses being everywhere sought for, and those not put to commercial uses being habitually neglected—save indeed by the man of science, to whom the peculiar properties of some of the less familiarly known elements, as palladium, osmium, erbium, didymium, uranium, and thallium, render them objects of the highest interest.

A very notable point with regard to the last-discovered four elements, namely, rubidium, cæsium, thallium, and indium, is their successive discovery within a few years of each other, by one and the same process, namely, that of spectrum analysis. This process, invented and made available as a means of chemical research by Bunsen and Kirchhoff in 1859, consists simply in allowing the light given off by different ignited gases and vapors, limited by means of a fine slit, to pass through a prism or succession of prisms; and in observing the so-produced, brightly-colored, widely-extended image of the slit. It has been known from the days of Newton, that, by the passage of heterogeneous light through a prismatic, highly-dispersive medium, its differently refrangible constituents become widely separated from each other, so as to furnish an elongated, colored spectrum. But, whereas the spectra of incandescent solid and liquid bodies are continuous, and not distinctive of the particular luminous bodies yielding them, the spectra of incandescent, gaseous, or vaporized bodies, are found to be discontinuous, and to consist of one or more bright lines of different color, thickness, and position, according to the nature of the particular incandescent gases or vapors from which the light through the slit is proceeding. In this way it is found that the spectra of the different chemical elements, alike when free and in combination, are perfectly definite, and characteristic of the particular elements vaporized and made incandescent.[1] And, in many cases, the spectra, or portions of the spectra of particular elements, even when present in the most minute proportion, are so extremely well marked and distinctive, that the presence or absence of these elements is determinable with the greatest ease and certainty, by a mere inspection of the emission spectra yielded by the incandescent gases or vapors under examination. Moreover, gases and vapors are further capable of affecting heterogeneous light which is passed through them; and of thus yielding absorption spectra, in which the characteristic lines of the above-described emission spectra are reversed, so as to appear, unaltered in position, as black lines or intervals in an otherwise continuous band of color.

Now, the salts of the alkali-metals, lithium, sodium, and potassium,

[1] For some qualifications of this statement, *vide* Roscoe's "Spectrum Analysis."

and certain of the salts of the alkaline-earth metals, calcium, strontium, and barium, being very readily volatile, upon heating these salts, in the non-luminous flame of a Bunsen gas-burner for example, they undergo vaporization, and their vapors become incandescent and capable of yielding the characteristic emission spectra of the particular metals. In examining in this way the alkali-salt residue of a mineral water from Durkheim, Bunsen observed in the spectrum before him certain colored lines not belonging to any one of the then known alkalies, potash, soda, or lithia; and yet necessarily belonging to some substance having the general characters of an alkali, since all other bodies than alkalies had been previously removed from the residue under examination. In full reliance upon the certainty of this conclusion, Bunsen evaporated some forty tons of the water in question; and from the alkali-salt residue succeeded in extracting and separating salts of two new alkali-metals, each characterized by a well-marked pair of lines in the blue or indigo, and one of them having in addition a pair of well-marked lines of extremely small refrangibility in the red of the spectrum. From its yielding those red lines, the one metal was named rubidium; the other, of which the bright-blue lines were especially characteristic, being called cæsium.

The very general distribution in Nature of these two elements was speedily established, and salts of each of them were, with much labor, eventually prepared in a state of purity and in reasonable quantity. From certain of their respective salts the metals themselves were obtained by the usual processes, and, together with their salts, were submitted to detailed chemical examination. And no sooner was this examination made, than the position of the newly-discovered elements, as members of the alkali-metal family, at once became apparent. Rubidium and cæsium were found in all their properties to present the most striking analogy to potassium, and evidently to stand to this metal in the same relation that strontium and barium respectively stand to calcium; while they differed from sodium, much as strontium and barium respectively differ from magnesium. This relationship in obvious properties was further borne out by the relationship of their atomic weights, thus:

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Mg | 24 | Na | 23 | F | 19 | O | 16 |
| Ca | 40 | K | 39 | Cl | 35.5 | S | 32 |
| Sr | 87 | Rb | 85 | Br | 80 | Se | 79 |
| Ba | 137 | Cs | 133 | I | 127 | Te | 129 |

It is observable that the sequence of atomic weight in the thus completed alkali-metal family is strictly parallel to the previously well-known sequences in the alkali-earth metal family, and in the halogen and oxygen families respectively. Moreover, just as the basylity of the alkaline-earth metals increases in the order of their several atomic weights—calcium being less basylous than strontium, and far less basylous than barium—so also is the basylity of potassium inferior to that

of rubidium, and the basylity of rubidium inferior to that of cæsium, which is indeed the most powerfully basylous, or oxidizable, or electro-positive element known.

Since 1860, both rubidium and cæsium have been recognized as minute constituents of a considerable number of minerals and mineral waters, rubidium having been met with for the most part in a larger proportion by weight than cæsium. Unlike potash, originally known as vegetable alkali, cæsium has not been recognized in the vegetable kingdom; but rubidium has been found as a very common, minute constituent of vegetable ashes, as those of beet-root, oak-wood, tobacco, grapes, coffee, tea, etc. On the other hand, cæsium, free from rubidium, has been found in a tolerably well-known, though rare, mineral from the island of Elba, to the extent of 32 per cent. by weight of the mineral. The history of this mineral is curious: from the circumstance of its always occurring in association with another mineral, a variety of petalite, the two were called Castor and Pollux. Castor was found to be substantially a silicate of alumina and lithia; pollux a silicate of alumina, and, as it was thought, of potash. The constituents of pollux, namely, silica, alumina, and potash, with small proportions of ferric oxide, lime, soda, and water, were duly estimated; but the quantities of these constituents, found in 100 parts of the mineral, instead of amounting to 100 parts or thereabouts, amounted only to 88 parts, there being somehow a loss of 12 per cent. in the analysis. After Bunsen's discovery of the new alkali-metals, pollux was analyzed afresh by Pisani, who soon perceived that what had formerly been taken for potash, and estimated as potash, was not potash at all, but cæsia. Then calculating out his own analysis with cæsia instead of potash, substituting the one for the other in the proportion of 133+8, or 141 parts of cæsia, for 39+8, or 47 parts of potash, he found that the quantities of the different constituents furnished by 100 parts of the mineral yielded by their addition the full sum of 100 parts required.

In submitting to spectroscopic examination a certain residue left by the distillation of some impure selenium, Mr. Crookes, early in 1861, recognized in the spectrum before him a brilliant-green line, from which he inferred the presence in the above residue of a new element; and by the end of the same year he had succeeded in establishing the tolerably wide distribution of this element, to which he gave the name of thallium; in procuring it, though but in small quantity, in a separate state; and in satisfying himself of its metallic character. Soon afterward, and without knowledge of Mr. Crookes's later results, the metal was obtained by M. Lamy, on a comparatively large scale, and was exhibited by him in the form of small ingots at the London Exhibition of 1862. He procured it from the fine dust met with in some oil-of-vitriol factories, as a deposit in the flues leading from the pyrites

burners to the leaden chambers. In these deposits, the minute proportion of thallium contained originally in the pyrites becomes concentrated, so as to form in some instances as much as eight per cent. by weight of the dust. Independently, moreover, of its occurrence in iron pyrites, thallium, though never forming more than a minute constituent of the different minerals and mineral waters in which it occurs, is now known to be capable of extraction from a great number and variety of sources. But from no other source is it so advantageously procurable as from the above-mentioned flue-deposit; and so early as the autumn of 1863, at the meeting of the British Association in Newcastle, the then mayor, Mr. J. Lowthian Bell, exhibited several pounds, and Mr. Crookes no less than a quarter of a hundred-weight of thallium obtained from this comparatively prolific source. In one respect, the discovery of thallium presented even a greater degree of interest than attached to the discovery of cæsium and rubidium. For whereas these two elements were at once recognized as analogues of the well-known metal potassium, thallium can hardly be said, even at the present time, to be definitely and generally recognized by chemists as the analogue of any particular metal, or as a member of any particular family of elements. With each of such differently characterized elements as potassium, lead, aluminum, silver, and gold, it is associated by certain marked points of resemblance; while from each of them it is distinguished by equally well-marked points of difference. Hence the necessity for subjecting thallium and its salts to a thorough chemical examination, so as to accumulate a well-ascertained store of facts with regard to it. And, thanks to the careful labors of many chemists, more particularly of Mr. Crookes, in London, and of Messrs. Lamy and Willm, in Paris, our knowledge of the properties of thallium and of its salts may compare not unfavorably with our similar knowledge in relation to even the longest known of the metallic elements. Still, it was not until our knowledge of indium had culminated in the determination of its specific heat, only last year, that the position of thallium, as an analogue of indium and a member of the aluminum family of elements, became unmistakably evident.

Indium was first recognized in 1863, by Drs. Reich and Richter, in the zinc blende of Freiberg, in Saxony, and by reason of the very characteristic spectrum afforded—consisting of two bright-blue or indigo bands; the brightest of them somewhat more refrangible than the blue line of strontium, and the other of them somewhat less refrangible than the indigo line of potassium. Since its first discovery, indium has been recognized in one or two varieties of wolfram, and as a not unfrequent constituent of zinc-ores, and of the metal obtained therefrom, but always in a very minute proportion. Indeed, indium would appear to be an exceedingly rare element, far more rare than its immediate predecessors in period of discovery. Its chief source is metallic zinc—that of

Freiberg, smelted from the ore in which indium was first discovered, containing very nearly one-half part of indium, per one thousand parts of zinc. A considerable quantity of indium extracted from this zinc, was shown in the Paris Exhibition of 1867; and an ingot from the Freiberg Museum, weighing two hundred grammes, or over seven ounces, has within the last few days been kindly forwarded by Dr. Richter himself, for inspection on the present occasion. To Dr. Schuchardt, of Goerlitz, also, the members of the Institution are indebted for his loan of nearly sixty grammes of metallic indium; and of fine specimens of other rare chemical products, prepared with his well-known skill, in a state of great purity and beauty.

When zinc containing indium is dissolved not quite completely in dilute sulphuric or muriatic acid, the whole of the indium originally present in the zinc is left in the black spongy or flocculent residue of undissolved metal, with which every one who has prepared hydrogen gas by means of zinc and acid is so well acquainted. Besides some zinc, this black residue is found to contain lead, cadmium, iron, and arsenic, less frequently copper and thallium, and in some cases, as that of the Freiberg zinc, a small proportion of indium. From the solution of this residue in nitric acid, the indium is separated by ordinary analytical processes, based chiefly on the precipitability of its sulphide by sulphuretted hydrogen from solutions acidulated only with acetic acid, and on the precipitability of its hydrate both by ammonia and carbonate of barium. From its soluble salts, metallic indium is readily thrown down in the spongy state by means of zinc. The washed sponge of metal is then pressed together between filtering-paper, by aid of a screw press, and finally melted under a flux of cyanide of potassium.

Thus obtained, indium is a metal of an almost silver-white color, apt to become faintly bismuth-tinted. It tarnishes slowly on exposure to air, and thereby acquires very much the appearance of ordinary lead. Like lead, it is compact and seemingly devoid of crystalline structure. Moreover, like lead and thallium, it is exceedingly soft, and readily capable of furnishing wire, by the process of "squirting" or forcing. The specific gravity of indium, or 7.4, is very close to that of tin, or 7.2; and much above that of aluminum, 2.6, and below that of lead, 11.4, and that of thallium, 11.9. In the lowness of its melting-point, namely, 176° C., indium occupies an extreme position among the metals permanent in air; the next most fusible of these metals, namely, tin and cadmium, melting at 228°; bismuth at 264°; thallium at 294°; and lead at 235°. Though so readily fusible, indium is not an especially volatile metal. It is appreciably less volatile than the zinc in which it occurs, and far less volatile than cadmium. Heated as far as practicable in a glass tube, it is incapable of being raised to a temperature sufficiently high to allow of its being vaporized, even in a current of hydrogen.

Indium resists oxidation up to a temperature somewhat beyond its melting-point, but at much higher temperature it oxidizes freely; and at a red heat it takes fire in the air, burning with a characteristic blue flame and abundant brownish smoke. It is readily attacked by nitric acid, and by strong sulphuric and muriatic acids. In diluted sulphuric and muriatic acids, however, it dissolves but slowly, with evolution of hydrogen. Oxide of indium is a pale-yellow powder, becoming darker when heated, and dissolving in acids with evolution of heat. The hydrated oxide is thrown down from indium-solutions by ammonia, as a white, gelatinous, alumina-like precipitate, drying up into a horny mass. The sulphide is thrown down by sulphuretted hydrogen as an orange-yellow precipitate, insoluble in acetic but soluble in mineral acids. The hydrate and sulphide of indium, in their relations to fixed alkali solutions more particularly, seem to manifest a feebly-marked acidulous character. Chloride of indium, obtained by combustion of the metal in chlorine gas, occurs as a white micaceous sublimate, and is volatile at a red heat, without previous fusion. The chloride itself undergoes decomposition when heated in free air, and the solution of the chloride upon brisk evaporation, with formation in both cases of an oxichloride.

## THE CAUSES OF PHYSICAL DEGENERACY.

By A. K. GARDNER, M.D.

WHETHER the human race is degenerating, and, if so, by what causes, are questions of much speculative interest to scientific thinkers, and of much practical interest to each father and mother in the community. The subject is complicated by many conditions. Physical health and vigor, and mental strength and power, are to a great degree a matter of hereditary transmission, over which the individual has no control. Yet, taking our natures as they are, we can renovate, reinvigorate, and advance them by attentive study of and conformity to the laws upon which health and vigor are based. I propose in the present article briefly to glance at the chief physical agencies—air, exercise, clothing, food, and rest—and at some of the mental and moral influences, by the bad or good employment of which the physical stock is deteriorated or improved.

*Air.*—Probably the inhabitants of the globe generally were never so thoroughly sheltered as at present. The house keeps off rain, dew, and the moistures from evaporation—certainly very desirable—but it also to a greater or less degree modifies the temperature and the quality of the air that we breathe.

Theoretically, air is admitted to be an agent conducive to life; prac-

tically, it is almost utterly disregarded. The necessity of breathing is recognized, and we have various formulated sayings implying that to stop breathing is to stop living. But, practically, the world is trying to see how little air can be actually used—and, with some, this is almost their only economy—and next, to see how poor a quality of air can sustain their life.

One-half of the civilized race—i. e., all the women, and some men—so dress themselves that by no possibility can they take a full breath. As the lungs are never fully inflated, their capability of expansion is gradually lessened. The result is, a contraction and diminution in the size of the chest, a want of roundness and fulness, and both men and women are "flat-chested," round-shouldered, and "sunken in." The eye will recognize this, and measurement will add certainty to judgment.

Take the men of New York to-day, and not one in five hundred can make a difference in the dimensions of the chest, from a full inspiration to a complete expiration, of five inches, measured at the nipple. Nor will the majority show an expansive capacity of even three inches. With the women it is still less; probably never since extreme childhood—for romping days end early now—have they been capable of taking a full breath in the daytime, the nearest approach to it being effected, not by the expansion of the chest, but by the action of the abdominal muscles and the downward withdrawal of the diaphragm.

Nor is this stated as a matter of simple curiosity; it has a practical and most important bearing on the subject under consideration. Supposing that the blood is sufficiently aërated without the use of the full capacity of the lungs, say by an increased number of respirations—are not the necessities of Nature thus adequately supplied, and consequently no injury done?

By no means, as every housewife's experience will abundantly illustrate. In the quiet and secluded angles and nooks gather the lint and dust of the whole apartment. In the corners and recesses of a hospital-ward gather the miasm and the pestilence. In the unused portions of machinery do we find the rust and tarnish, and the mildew blasts the quiet and the still parts of all Nature. In the same way, in those portions of the lungs, every minute extremity and division of which is a reticulated net-work of fibres, and vessels, and tubes, through which, at every expiration and subsequent inspiration, there should be an unceasing ebb and flow, with new elements constantly adding, and effete material perpetually renovating, yet, by reason of mechanical impossibility, there gather the results of this stagnation, the crassness of the blood, and those discordant elements which, had they not been allowed to accumulate in these undusted retreats, would have continued in the circuit of the blood, till they had arrived, in due course, at some of the great glandular strainers and purifying alembics

of the system, where they would have been duly eliminated and discharged. These localities are the nuclei of disease, and here are deposited the tubercle and the germs of death.

This is the result of disuse—the farmer's neglected spot, the receptacle of odds and ends, never ploughed nor cared for, where weeds run riot, and whence every light-winged breeze wafts the myriad progeny of evil all over the adjoining fields.

How aggravated is this condition when the air, too, is deteriorated, full of miasm and pestilence! See the air of the swampy, undrained country, laden with agues and typhus, or the city atmosphere, shut in from sun and breeze, respired over and over again by the healthy and the sickly, by animals of every description, full of the dust of every production of the world, with the fumes of every volatile liquid and deleterious gas!

When we contrast this single vital element as it enters into the life of the modern man, compared with its free use by the men of the past, who are reported to have lived to a great age in health and comparative vigor, does there not seem to be almost reason enough for it in this fact alone?

The Greeks, like all Eastern nations, lived in the open air. The patriarchs of the Bible lived in tents. Even those of later date, who lived in the small cities of former days, occupied no tightly-glazed, windowed apartments, but slept a great part of the time on the unbedewed roofs of their houses, covered only by the radiance of the gentle moon and the twinkling stars.

In those days the heat came from the vigor of the system, and exercise at some useful employment, while wide-mouthed, gaping chimneys, consuming huge logs of timber, carried away, on their upward draught (with most of the heat indeed), the air wasted by respiration.

Nor was pure air a royal prerogative; for, down to quite recent times, these immense chimneys were the gates to health to our own ancestors, and we ourselves learned somewhat of our early astronomy by gazing at the stars through these huge telescopes, thickly hung around with the flitches of bacon and fat hams quietly absorbing the pyroligneous acids from the consuming logs of oak and walnut burning below.

Contrast those long winter nights in rooms through whose open cracks the wintry blast not unfrequently blew out the candle by whose dim light we groped our shivering way to bed; contrast them with the air we breathe, heated by the unceasing furnace, poisoned by ever-present tobacco-smoke, and at the best loaded with the impurities of a city, and passing on its course from house to house, constantly becoming more and more impure.

*Sunlight.*—This portion of the subject cannot be honestly left without some allusion to the marked influence which the sun has upon all Nature, both animate and inanimate. Hygienic writers have generally most astonishingly ignored the powerful effects of this luminary,

the centre of life and heat, and without which vegetable life would be a nullity. Can we, therefore, doubt its energizing potency upon animal life?

It is not only poets and sentimentalists that have acknowledged the importance of the moon and the stars as hygienic mental and spiritual influences upon man, but grave doctors and learned searchers after truth have been ready to add the weight of their judgment to the superficial imaginings of the common thought. The moon has been deemed almost the arbiter of man's destiny, for every thing was supposed to be attached to the mystery of its quarterings, and its coming or going was (and is) supposed to have a gravity utterly untenable upon any scientific principle; and yet to the great orb of day, of which the moon and stars are but reflections, and to which we are compelled to directly ascribe life and vigor, so little attention has been paid—perhaps from the comparative absence of mystery—that its importance has been, till lately, unrecognized by hygienic writers.

The long-lived generations of the past did better than worship the sun: they lived in its light, bathed in its warmth, and had their spirits and material substance imbued with its life-giving potency. Instead of sun-penetrated tents, men now live in thick-walled dwellings, through whose stony externals the solar warmth cannot strike to dry up the dank humidity, and the sparse and infrequent rays, that might perchance enter through the narrow windows, are carefully shut out by the voluminous folds of ornamental silks, lest the rich carpets be faded thereby. And the dwellers within live in darkness of vision and intellect, ignorant that they are excluding the royal visitor to whose gracious coming every avenue should be thrown wide open, to admit the king possessing a true "royal touch," potent to the cure of more ills than was ever ascribed to earthly sovereign.

There is a prospect of some return to a renewal of the beneficent influences of the sun, from the sheepish followers of fashion. This fickle goddess has recently started the doctrine that, as a reaction from the tanning effects of a summer's out-of-door exposure, the winter's change adds new brilliancy and transparence to the complexion. Fashionable butterflies now seek for the most complete tanning that the summer's solstice can effect, in order to secure a corresponding reaction, and insensibly gather health and invigoration.

Contrast the myopic and weak-eyed men of the day with the eagle-eyed men of the plain and forest, whose sight needs no screening from the sunlight, by broad visor and head-apparel or dainty parasols. To their unshrinking eyes light has no perils or disagreeableness.

Have we not here another great contrast between the past and the present? Where picturesqueness may have gained from the embowered cottage and the shaded dwelling, has not health suffered. The city, thronged with high residences and warehouses, has shut out the potent rays of the sun, and humanity has grown pallid in its shade, like

the inhumed celery-plant or the wide-spreading, spindling sprout of a cellared potato. Here in New York, and in London, Paris, and Berlin, the typhus sick are removed from the hospitals and placed in tents open to air, and purified by the radiance of the health-giving sunbeams. If thus potent for cure, how irresistible for prevention!

*Exercise.*—The Greeks made exercise a part of education, and the athlete, if not also a philosopher and a poet, or a tragedian and orator, was at least esteemed as highly by the community. Exercise was a part of every one's life, a business, a pleasure, and a necessity.

Till quite recent days, there were no lazy people, no gentlemen, none inactive. War and its martial exercises, labor and its attendant fatigues of the body, the chase and its toils, housewifery, the fabrication by hand of all the necessities of life—these healthy exercises have been done away with by excessive wealth, the fashion of indolence, and steam appliances. Work being now denounced by fashion, and delegated to servants, the women of the country have no severer toil than playing the piano and dancing, with an occasional saunter in the street on a very fine day. Consequently, the languid blood flows through unstimulated veins, resembling the stagnant, slime-covered waters of an undisturbed canal.

The city man, if very vigorous, priding himself upon his powers, walks down to his business from 8 to 10 A. M., and occasionally back again, in a gentlemanly manner, which means not fast enough to be ungraceful, or to moisten his shirt-collar. During the interval between these periods, he sits or stands at a desk or behind a counter. If there is a box to be opened, a bale of goods to be sent aloft, or put into a cart, he calls the porter. Possibly he takes a half-hour turn with some Indian clubs or dumb-bells, in the house, and, of course, where fresh air is tabooed. If he has means, he gets a trotter in a motionless buggy, and over a level road he walks six miles, and then trots fast two miles in great excitement, using his arms and possibly his lungs with some vigor. This is the exercise of the modern athlete, philosopher, and business-man.

*Clothing.*—The anti-imaginative character of the nineteenth century sets aside the fanciful ideas of the origin of clothing being due to a sudden outburst of modesty. It undoubtedly originated from the exigencies of climate; it was a shelter from the burning sun and a protection from cold and wet. By degrees, this original design became forgotten, and fashion, driving out both original necessity and created modesty, usurped the control of dress, and, like most conquerors, has endeavored to eradicate every possible trace of its original design. Health and comfort and life are disregarded as much as possible. The young child is so dressed as to expose its dimpled arms and its sweet amplitude of neck, and sent to walk, no matter how chill and blustering the weather, with its plump legs unstockinged and bare.

But the improvement in manufactures and the general adoption of

machinery into the making of cloths, and especially the general use of the sewing-machine in the fabrication of garments, have made such a difference in the comparative cost of clothing, that it may be believed that never before was the world so comfortably dressed as at present; and the future has still further assistance for the poor, for even now the great labor of cutting is so far modified by mechanical appliances that by the same operation of a single shears a dozen garments are simultaneously struck out, and the final cost is thus materially diminished.

The tendency of daily dress throughout the world, imperfect as it is, is yet an improvement upon the past, and life is rather prolonged than curtailed by the change. The corset, allowing all the objections—and they are not entirely correct—that may be urged against its use and abuse, is yet far in advance of the steel bars, like animal cages, of former days. So far, then, as clothing is concerned, no physical degeneration can be ascribed to modern changes, but, on the contrary, the slight alteration has been for the better; and, other things being equal, its beneficial effects would be markedly evident.

*Food.*—If we look at the entire population of the inhabitable globe, in the different centuries, we can, with each succeeding age, note an alimentary improvement. We see now few famines bearing widespread destruction in their path. The intercourse of nations, the sympathy of a recognized common humanity, the spirit of trade and commerce, the rapid communication by telegraph, and the power of applied steam, have united to prevent the possibility of a great national famine in the future. The world now feeds the world, and a dearth in one locality is supplied by the affluence of another.

The continual opening of new territories of immense extent, and seemingly inexhaustible richness, and most of all the frequent discovery of new grains, roots, and fruits, and the development and improvement of the old, seem to insure the world for the future against local destitution and suffering of this nature. More than any one thing else, the discovery of the potato has effected this end; while the introduction of Indian corn and the utilization of the animal life that roam over the immense prairies of America, in both a wild and domesticated state, add a large quota to the alimentation of the world, and have raised the physical stamina of humanity.

But while it is acknowledged that the race down to its lowest strata of humanity is improved and improving, the same statement is not true respecting the higher classes. While the average stamina is greater, theirs is unquestionably deteriorated.

We have already shown the injurious results which wealth brings, in depriving the rich of exercise, by taking away its mainspring, in substituting fashion for necessity; it exerts a far more deleterious influence when it ministers to the appetites.

There is a wealth of wisdom in the remark of Abernethy to the rich

dyspeptic, the extent of which he probably never dreamed of himself when he uttered it: "Live on a shilling a day, and *earn it.*"

This sentence, translated into the language of the present, in New York, would be to each individual, "Earn a dollar a day and feed yourself with that alone." This would approximate to living healthily —as did our forefathers—though it is impossible for a man of ordinary means to feed himself healthily in New York, because bread is a prime necessity. The greater part of the flour which comes to the market is but little different from pure starch, so thoroughly is it bolted by the miller, so thorough-bred (no play on the words) is the grain itself. The wheat itself has suffered in its nutritious qualities by the extreme care taken in its cultivation. The canary-bird fancier, in his zeal to raise high-colored birds by interbreeding, obtains his buttercup-yellow, but at the cost of a very scanty plumage. The stock-raiser gets his thorough-bred horse with his thin neck, small head, diminutive ears, greyhound legs, and peculiar barrel, but with them a high nervous organization and uncertain temper, that make the animal impracticable for the ordinary pursuits of life. The same state of things is seen in the wheat of the country, which, having first nearly exhausted the unfertilized soil, finishes by being itself exhausted of the nutritious phosphates and nitrogenous elements so necessary for the bone and nervous tissues of the human frame. This is very important, especially for the young, a great portion of whose alimentation comes from bread. Add to this deprivation of essential elements, the substitution of starchy substances capable of but imperfect assimilation by any stomach, especially that of a young child, and we have an important source of animal imperfection and debility.

We find like cause of degeneration if we look at another leading source of the life of children—*milk.* Dr. Nathan Allen, in his recent elaborate article ("Physical Degeneration," JOURNAL OF PSYCHOLOGICAL MEDICINE, October, 1870), says that American women are to a great extent incapable of nursing their children, and that they necessarily resort to the bottle and cow's milk. How bad is this substitute, very few have even surmised. We know there is no exaggeration of the ill results from the use of the so-called swill-milk, which, in greater or less quantities, furnishes the chief supply of all our large cities and towns. The present writer made the initial observations on swill-milk, in New York, and his report to the Academy of Medicine was the basis of the subsequent general interest in the subject. This milk is deleterious, because new principles are introduced into the milk, and the normal ones distorted and rendered almost nugatory.

But, setting this matter aside, let us look at the healthy milk of the whole country, and perhaps of the world. What is it?

When a woman, in the vigor of health, while nursing her own child at the breast, becomes again pregnant, her first knowledge of and attention to this fact frequently arise from the effects of her milk upon

her nursing babe. Sometimes the child grows meagre, pallid, is evidently not thriving; occasionally has spasms from apparent indigestion; at others, it is often nauseated, and ejects the curdled milk, with or without accompanying diarrhœa. The child is withdrawn from the breast, proper food is substituted, and a manifest improvement commences immediately.

There is a similar cause for a depraved condition in all the milk of the country. No sooner is the calf taken from the dam—say, when six weeks old—than she is again impregnated. In the ordinary course of Nature, her milk would "dry up" on the occurrence of this event; but she is regularly milked twice a day, and thus it happens that all the milk upon which our children are raised has been first deprived of its essential ingredients to nourish the next year's calf.

If any one questions the effect of this double attempt at nutrition, let him compare the milk in ordinary use with that of a "farrow" cow. The latter is small in quantity, thick, redundant in cream, dark in color, of a very high flavor, so as to render it quite unpalatable. This is the milk destined to strengthen the bones and invigorate the energies of the young offspring. It is such milk as this, undrained of its essential elements, that the child demands from his mother. It asks for bread, and you give it starch. It asks for milk, and you give it—what?

In the lack of the natural maternal nutriment, as alleged by Nathan Allen and other eminent writers on this and kindred topics, does not the general use of this deteriorated cows' milk for so many years, as a substitute or as a supplement to supply this general deficiency, point to one among the many causes of physical deterioration?

If any evidence is wanted to show the imperfect nutrition of the better classes, it may be found in the frequency of dyspepsia, scrofulous diseases, and deaths from diseases of exhaustion and debility, as contrasted with the general vigor, capacity for prolonged exertion, digestion of immense dinners, excessive drinking, and general deaths from inflammations, plethora, apoplexies, congestions, gout, and the like, which were the main causes of the death of our forefathers.

If it is also noticeable that the mean of life is now shorter than formerly—as we think it is—then it is deducible that, among other causes, imperfect nutrition holds a prominent place.

Now, when we compare the diet of the past with the present, we find to-day evidences of a delicate and finical appetite, and an enfeebled digestion. The name of "the roast-beef of old England" lives almost but in name; for the degenerate Britons and allies seek for the kickshaws, spiced *entremets*, and flavorous nothings, of still more degenerate nationalities. The vigorous appetites are wanting, and, possibly, the debile gastric juicé, arising from a lack of physical exertion and an excess of mental stimulus, may be the active cause of the general physical deterioration so markedly present throughout the civilized world.

There are certain enthusiasts who ascribe all the ills of flesh to certain special causes of comparative trivial importance, but their crude theories are based upon such imperfect data as necessarily to render their deductions of little value. The most cadaverous-looking of them all are the ultra-Grahamites, whose appearance alone is generally sufficient to contradict the assertions that human decadence is due to an animal diet.

The ultra-temperance partisans have a far stronger argument for the entire disuse of all stimulating beverages, upon moral rather than upon physical grounds; as it is undoubtedly the fact that the character of the diseases of the world has been more modified by the disuse of liquors, etc., than from any one other cause; and to this is ascribed the substitution of the present diseases of inanition for the former inflammatory and congestive affections resulting from over-stimulation.

Still a third class ascribe the deterioration of the race to the increasing use of narcotics, and mainly of opium and tobacco. Every instance of present disease and the use of either of these drugs, in large or small quantities, are considered to be cause and effect.

Unquestionably the excessive use of all these powerful nervines and narcotics has a deleterious effect upon the animal economy, but the extravagant accusations of these ultraists prevent the truth from being acknowledged, and perhaps any consideration of the subject from being entertained. One writer's assertion may be mentioned in illustration of this remark. He says that one using tobacco freely is so permeated by its deleterious properties, that the ordinary mosquitoes, flies, and household vermin, flee from his presence, a statement so at variance with generally-recognized facts, that the entire theory of the perhaps otherwise correct writer is discredited thereby.

Unquestionably, the excessive use of tobacco and spirits—as some sensualists constantly continue under their influence—must have a marked effect upon the nervous energies, thereby interfering with the powers of assimilation and reproduction. It may be, as alleged, that this loss of vigor is entailed upon succeeding generations, and that to these influences may be in truth ascribed some considerable portion of the physical decadence which so characterizes the present epoch.

*Rest.*—Perhaps it may be true that all Nature requires rest. This is remarkably evident in most, if not all, forms of vegetable and animal life. Plants have their alternate periods of growth and apparent rest. Animals have their periods of activity and repose. The muscle cannot keep up its continued contraction; and the body, wearied by persistent toil or action, however light or pleasing, sooner or later demands rest, and the entire muscular system gives itself up to repose, with the exception of the continuous breathing and the persistent beating of the heart. So far as we can judge, the action of the brain must also have its period of quiescence, with complete abnegation of its wondrous voluntary and involuntary activities.

The laboring-man, fatigued by the wearisome hod, takes his nooning in any sequestered spot; but his inactive brain requires not sleep to refresh it, for no task has been imposed upon it, and he needs but to rest his limbs in the pleasant shade. A too prolonged exertion is followed by muscular irregularities, cramps, exhaustion, and rheumatic incapacities, effects disagreeable enough, but generally of temporary duration, and with little or no permanent effect on the general constitution or on succeeding generations.

## SKETCH OF PROF. GRAY

WHEN we enumerate the few great living botanists, the list must include Dr. Asa Gray, Fisher Professor of Natural History at Harvard University. To the average reader, this may not imply any great distinction, as a botanist is too commonly looked upon as merely one who can call plants by name. Making specimens and naming plants no more make a botanist than taking an altitude makes an astronomer.

It is not our purpose to show here the scope of botany, nor to consider its claims to an equal rank with other departments of science.

Suffice it to say that it affords exercise for the keenest observation and the most skilful diagnosis; that the closest reasoning, the most thoughtful weighing of evidence, the acutest application of the logic of facts, in short, those qualities of mind that are required in any other scientific pursuit, are demanded of one who would take a high rank as a botanist. We would not be understood as speaking disparagingly of the humbler laborers in botany, for each one in his way does something for the general good. In all sciences the units are accumulated by patient workers whose isolated facts seem to have but little importance of themselves, but, when brought by some master-mind into relation with other facts, they often prove to be the missing links to a heretofore incomplete chain.

Prof. Gray was born at Paris, Oneida County, New York, November 18, 1810, and took the degree of M. D. at Fairfield College in 1831, but relinquished the medical profession for the purpose of prosecuting the study of botany. He was appointed botanist to the United States Exploring Expedition, in 1834, but, in consequence of the delay of that enterprise, resigned his post in 1837. He was elected Professor of Botany in the University of Michigan, but, before that institution went into operation, he took the position of Fisher Professor of Natural History in Harvard University, in 1842, where he now is.

One of the earliest if not the very first contribution of Dr. Gray to botanical literature is his "North American Gramineæ and Cyperaceæ." Two volumes of this were published in 1834–'35, each containing a hundred species, illustrated by dried specimens. Several new species

were described in these volumes, and much was done toward revising the characters and synonymes of the older ones. The work was published by subscription, and, from the labor involved in its preparation, only a limited edition could be sent out. It is now a very rare work, but one which must be quoted by whoever would write upon the grasses or sedges of North America.

A paper was read before the New York Lyceum of Natural History, in December, 1834, entitled "A Notice of Some New, Rare, or Otherwise Interesting Plants from the Northern and Western Portions of the State of New York, by Asa Gray, M. D." This first brought its author prominently before the botanists of the day. It was a matter of no little surprise that a young man, working in a field heretofore thought to be well explored, should not only bring to light several new species, but clear up the confusion that surrounded many which had long been kept in a state of uncertainty by the older botanists.

In 1838, the first part of the "Flora of North America" appeared under the joint authorship of John Torrey, M. D. and Asa Gray, M. D. It proposed to give "abridged descriptions of all the known indigenous and naturalized plants growing north of Mexico." This was published in numbers from time to time, and was suspended at the end of *Compositæ*. The value and thoroughness of this work, the faithfulness with which it embodied all that was known of our plants up to the time of publication, can only be appreciated by those who have had occasion to use the work. It is so frequently quoted as "Torrey and Gray," that had these two eminent coworkers made no other contributions to the science, they would still be accorded the title of our first botanists. The union of these botanists upon the Flora was most fortunate, as each had special fondness for certain parts of the work, and thus, the labor being divided, the whole became more complete than if either had undertaken the entire task. If we mistake not, the *Compositæ* of the Flora was mainly the work of Dr. Gray—a task the difficulties of which can only be appreciated by working botanists. The relations between the authors of the Flora have been charming to those whose pleasure it has been to know of them, and are most touchingly expressed by Dr. Gray in the dedication of his Manual in 1867, in which he writes: "To John Torrey, LL. D. Almost twenty years have passed since the first edition of this work was dedicated to you —more than thirty since, as your pupil, I began to enjoy the advantage of being associated with you in botanical pursuits and in a lasting friendship. The flow of time has only deepened the sense of gratitude due to you from your attached friend." We have said thus much about Torrey and Gray, for it is not possible to speak of the botanical career of one without reference to the other.

It was stated that the "Flora of North America" was suspended with the completion of the Composite Family. When the work had reached this point the phrase "growing north of Mexico" had a widely-different

meaning from that expressed by the same term when the work was commenced. The annexation of Texas, the acquisition of California and other territory by the Mexican War and, later, the Gadsden Purchase, changed not only our geographical but our phytographical boundaries. Individual and government explorations were pushed not only into the newly-acquired Territories, but our older possessions were more thoroughly examined, and materials came in at such a rate that to continue the Flora as then commenced would require an appendix larger than itself. Each of its authors then occupied himself with studying the new materials as they came to hand, and in giving their results to the scientific world. This interruption of the Flora was followed by the publication, by both Dr. Gray and Dr. Torrey, of a series of most valuable botanical memoirs, sometimes conjointly, but oftener separately. These may be found in the various Government Reports, and in the transactions of the American Academy of Arts and Sciences, of the Smithsonian Institution, and other learned bodies.

The most conspicuous of these contributions to our North American Botany by Dr. Gray are, "*Plantæ Lindheimerianæ*," giving an account of the plants collected in Western Texas, by F. Lindheimer; in this memoir he was aided by Dr. George Engelmann; "*Plantæ Fendlerianæ Novi-Mexicanæ*," a description of the plants collected in New Mexico, by Aug. Fendler; "*Plantæ Wrightianæ Texano-Neo-Mexicanæ*," describing the extensive collections of Charles Wright, A. M. This paper is in two parts, and illustrated. Another memoir, "*Plantæ Novæ Thurberianæ*," though shorter than those already named, is important as describing an unusual number of new genera and species. These contributions are not confined to the working up of the materials of the particular collections of which they treat, but in many cases whole genera are elucidated and rearranged in a masterly manner.

These memoirs are mentioned out of their chronological sequence, as they may be considered, as well as those published by Dr. Torrey, as material accumulated for the use of whoever may undertake that Flora of North America for which botanists are hopefully looking.

In 1848 appeared the first volume of "*Genera Floræ Americæ Boreali-Orientalis Illustrata*," or, as it is best known, under its shorter title, "Gray's Genera." The object of this work was to give a typical specimen of one or more species of each genus of North American plants, with accurate analyses. The drawings for this work were made by Isaac Sprague, and for accuracy of detail and neatness of execution have not been excelled. Two volumes, containing one hundred plates each, were published, when, to the regret of all American botanists, the publication was suspended for the same reasons that we have given for the discontinuance of the "Flora."

The most voluminous and in some respects the most important of Dr. Gray's contributions to science relate to extra-American botany; we refer to the "Botany of the United States Exploring Expedition."

All the various collections made by the expedition of Commodore Charles Wilkes, during the years 1838–1842, save those collected upon our own Pacific coast, were placed in Dr. Gray's hands for elaboration. The collection comprised plants from widely-separated, insular, and continental floras, and the work was one which a less able botanist would have hesitated to undertake. How well the task was performed, two elegant volumes, which are better known in Europe than they are with us, stand as abundant evidence.

In this brief *résumé* of his labors, in systematic botany, we can but merely allude to a host of *opuscula*, or minor contributions—minor only in reference to their size, but of the highest value in their relations to science. These exist in the form of contributions to scientific journals, and to the proceedings of societies or academies. Some are devoted to the clearing up a knotty point in physiology or in classification; some contain the revision of a whole family or genus; while others are devoted to the working up of smaller collections than those comprised in the memoirs already referred to. Nor must we overlook the contributions which for years have appeared in almost every number of the *American Journal of Science and Arts*, of which Dr. Gray has long been one of the editors. In these notes the American reader has been kept *au courant* with all the best work of European botanists.

Such is an imperfect enumeration of our first botanist's contributions to the science; but there remains a greater than these to mention—his elementary works. However we value his labors in the higher departments of science, we render him our gratitude when we look upon what he has done to open a welcome door, through which not only the student, but the reader of average intelligence, and even the child, can enter the heretofore exclusive domain of Botany. Those who now take up the study of botany can have little idea of the difficulties that beset us of a generation or so ago. Where we groped and guessed, doubtful whether we were on the right path or the wrong one, the way is now made clear. The old rubbish is brushed aside, and the student now can walk in pleasant paths, guided by the clearest light of modern science. It is his untiring efforts to popularize science (in the true sense of the word) that has given Dr. Gray a lasting claim upon all who are interested in education and culture. As early as 1836, he published the "Elements of Botany," which grew into the "Structural and Systematic Botany," or "Botanical Text-Book," of the present day, a work that, through its various editions, has kept pace with discovery, and at each issue has stood as the best exponent of the state of *vegetable physiology* in any language.

In 1848 appeared the "Manual of the Botany of the Northern United States," in which our Flora was presented in a compact volume, with concise descriptions. This admirable work has passed through several editions, each one an improvement upon its predecessor, and it now stands unequalled as a local Flora.

When this work first appeared, distinguished botanists abroad thought it either a waste of time or beneath their dignity to be engaged upon popular works; but of late years we find that the most eminent of them are putting out their "Hand-books" and "Popular Floras."

As highly as we value the "Text-Book," we think that in books of this character his "First Lessons" is not only a superior work, but the best work upon elementary science of any kind that we are acquainted with. It is indeed a wonderful attempt at popularizing science. What are considered abstruse points in physiology are told with such a matter-of-fact simplicity, that the reader is charmed as with a tale, and, after reading it, is in possession of more of the philosophy of botany than he could obtain from a dozen more pretentious volumes. We can only just allude to his charming works for young people, "How Plants Grow" and "How Plants Behave," works which, though written for children, will be found to contain bits of wisdom for older heads.

The work that we have indicated implies a great amount of labor, and Dr. Gray is essentially a worker. No mechanic goes to his daily task more faithfully or continues at it with more assiduity than he. Very few, who are not familiar with the laboratories and studios of scientific men, have any idea of the amount of labor performed in them. Their work is by the many looked upon as a sort of half play, not to be compared, in its demand upon the physical and mental resources, with the daily task of the book-keeper or cashier. There are not many who work harder than Dr. Gray, but, when work is over, few more keenly enjoy the relaxation. One of of our pleasantest recollections of him is seeing him, after a hard day's work, engaged in a rough-and-tumble frolic with an enormous Newfoundlander.

It is supposed by many that a student's life diminishes bodily vigor. We can name several striking illustrations to the contrary, and eminent among them is the subject of our sketch. We have not tried a walk with him for several years, but we venture to say that few young men of twenty could take an afternoon's tramp with him and not feel a sense of relief when the excursion was ended.

Outside of the domain of botany, Prof. Gray's contributions to literature are not a few, but, as these were contributed to the *North American Review* and other magazines anonymously, their authorship is not known outside of a small circle. Some of his reviews are remarkable specimens of acute criticism, in which the subject could forget the sharpness with which he was flayed, in admiration at the dexterity of the operator. The estimation in which Dr. Gray is held by his scientific compeers is attested by the fact that he has for several years been the president of that distinguished body of scientists, *The American Academy of Arts and Sciences*, and is for the current year the president of the *American Association for the Advancement of Science.*

# EDITOR'S TABLE.

## *MODERN STUDIES IN EDUCATION.*

WE hold educational reform to be the first and most important of all reforms. There are many things in this world that need amendment, and, happily, there are plenty of people willing to help on the work. By diverstiy of tastes and division of labor, the business of reform is taken up piecemeal, and it is but natural that each party should clamor for the precedence of its own projects over all others. Some think the world is only to be regenerated by reforming its drinks, others its meats, others its recreations, and others its times of labor. Some are sure that what society most needs is better land-laws, others that it is better revenue regulations, and others, again, wider suffrage or free-trade, or a closer sorting of office-holders. Admitting that much good is yet to be attained in all these directions, there still remains a more radical and comprehensive task of reform. Our notion is, that the great agency which undertakes to prepare human beings for their work in life by awakening and directing their feelings, and by furnishing them with ideas and knowledge, is in extreme need of thorough amendment. Because, as men feel and think, so will they act; as are its constituents, so will be society; and, until people are better instructed in the things which pertain to their true welfare, all other reformatory schemes will yield but partial and unsatisfactory results.

But the phrase "educational reform" is vague and capable of various meanings. That phase of it which is destined to work out the most extensive and salutary effects will consist, we believe, in reconstituting the general methods of study upon a scientific basis. What the world wants now, to give effect to philanthropic aspiration, is to know what to do and how to do it, and the great means to this end must be found in comprehensive scientific education. But there is much misapprehension and some misrepresentation as to what is properly meant by scientific education. Its advocates urge the increasing study of science, and it is charged that they would make education consist in the bare acquisition of physical facts. They protest against the excess of traditional studies, and are reproached with the desire to sever our mental connection with the past. They object to the time given to Greek and Latin, and are accused of being the enemies of language in education. In short, they ask the introduction of new studies into an old system which already covers the whole ground and occupies all the time; and, as this can only be done by abandoning much that is established and venerated, the advocates of this change are characterized as the narrow-minded foes of all liberal culture.

These imputations are, however, erroneous and unjust. What the advocates of scientific reform in education demand is, not that everybody shall become chemists, or astronomers, or geologists, or that the past shall be ignored, or language neglected; but they demand that the unfolding mind of the age shall be put into more direct relation with the present realities of the world than our traditional culture allows. They ask but the thorough modernization of educational systems; and, as the characteristic and controlling element of modern thought is science, they maintain that this should be the characteristic and controlling element of culture. They are the enemies of neither literature, language, nor his-

tory, but they insist upon a better opportunity for modern literatures, modern languages, and modern history; and that modern science, by which all these subjects are more and more interpreted, and which is itself the transcendent intellectual interest of the age, shall have the leading place in schools of all grades. Holding to the practical value of positive knowledge for use and guidance in both private and public life, and seeing that it is as true now, as it was in the days of the prophets, that the people perish for lack of it, they demand such a reorganization of educational work as shall most effectually secure this end. The reform now required is, to make available for society the stores of valuable applicable truth which is the latest and highest result of human thought.

And this is a work that remains yet to be done. If it be said that changes have already been made and institutions modified so that modern knowledge is practically attainable, we reply that it has been nothing more than attempted. Notwithstanding the endless talk, the tide of influence is powerfully against the reformers. The question is not what special arrangements may have been made to meet special cases, but what is the ascendant ideal which governs the general practice. When a mother is ambitious that her son shall have a liberal education, and commits him to the accredited agencies, the question is, "What will become of him?" It is notorious that a pupil can go through a course of so-called liberal study, and graduate with honor at the highest institutions, in complete ignorance of that vast body of facts and principles which has arisen in modern times under the name of science, and the object of which is to explain the existing order of the world. There are great educational establishments from which modern knowledge is almost entirely barred out, and which oppose its intrusion with all their power. They fight the "encroachments" of modern science, modern literature, modern language, and modern history, at every point; and it is equally certain that this scheme of higher education in the ancient seats of learning reacts with great power upon inferior institutions, making them also unsympathetic with modern ideas as means and objects of culture.

It is true that we have scientific schools, and that they are doing an excellent work; but the shape they are compelled to take sufficiently attests the vigor and vitality of the traditional system. Where allowed to exist at all, they generally take the form of separate and supplementary institutions — outside appendages to the older colleges which, having grudgingly made this concession to "popular clamor," cling resolutely to their inherited methods. The new schools, in fact, became an excuse for resisting all modifications in the policy of the old, for it is said that the new wants are abundantly supplied by the new arrangements. Meantime it is assiduously maintained that the technical schools are only fitted to make chemists and engineers, and cannot educate in any broad or liberal sense, while thorough culture — the complete training of men — can only be accomplished by the old classical colleges. It is, therefore, as far as possible from true that the public have as yet realized the advantages of modern knowledge in education.

In an able article in our present number, Canon Mozely has shown not only the educational importance of modern literature, but he has shown also how grossly it is neglected in the English universities; and this testimony is the more valuable, as coming from a doctor of divinity, trained in the classical system, and holding a distinguished place in the University of Oxford. How desperate has been the struggle for the past generation to get even the nominal recognition of the sciences in these establishments is well

known; and how they have languished, when introduced, is equally notorious. The modern languages have fared no better, although, after a long contest, a point has at last been gained in their favor at Cambridge, which is thus described in *Nature* of June 6th:

"An event occurred on Thursday last at Cambridge, not in itself, perhaps, of imposing magnitude, but yet fraught with very important consequences. For this long while back an agitation has been going on with the purpose of making Greek no longer absolutely essential to the Previous Examination (or 'Little Go,' as it is popularly called), but of allowing French or German, or both, to be substituted for it at the option of the candidate. As any long-headed man might have foreseen, the genuine scholarship and liberal intelligence of the university are in favor of such a change; but the opposition has been neither feeble nor silent. Discussion has abounded more and more, and 'fly-sheets' have fallen like the latter rain. The advocates of the change seem to have been more or less governed by a dislike to many words, and to have had large faith in the merits of their cause; their opponents, on the other hand, appear to have believed in the efficacy of much speaking, and in the effects of arguments drawn from all quarters, and looking all ways; their papers and speeches, all put together, form as pretty a piece of incoherence as may be found in a literary day's march, and would have been a perfect godsend to the great Skepsius when he wrote his famous tract '*An hominibus mens absit.*' The reasons, indeed, for making the change were so clear and cogent, that there seemed hardly any hope of its being accomplished. Yet, by one of those freaks of fortune which are met with even in the universities, wisdom prevailed; and by the vote of the Senate on Thursday last, which will, in all probability, be speedily ratified at a second meeting, the student who desires to go out in an 'honors' examination henceforth need not at his Little Go scratch up a smattering of bad Greek, if he satisfies his examiner that he possesses a real knowledge of French or German. We trust that the scientific workers at Cambridge will take heart at this happy issue of the struggle, and gird up their loins for the heavy task of introducing order and system into the chaos in which the natural-science studies at Cambridge are now lost. It is not a little to the credit of this university that she should have been actually the first to remove one more of the old-fashioned swaddling-clothes which have been checking the development of youthful science, and we trust it is an earnest of still greater changes which she means to take in hand. Science has been too long at that old university a sort of blind Samson, bound with many cords, and serving chiefly to make sport for mocking Philistines of the classical and mathematical tribes. It is time his cords were loosed, and his strength made use of for the general advancement of the university."

### *ANTHROPOLOGY AND ETHNOLOGY.*

These are hard words, and will be ranked by many among those pestilent "ologies" of which so much is said by the learned, and which are supposed to be of so little use or importance to ordinary people. Yet they are significant and indispensable terms, and stand for very weighty things; and, moreover, they represent subjects which are forcing themselves more and more upon the attention of intelligent people. It is, therefore, desirable to have distinct conceptions of what they mean.

*Anthropology* is the term now applied to the general science of man. It, therefore, comprehends many things, and has, perhaps, not yet reached its

full and final definition. It embraces men's physical, mental, and moral characteristics; their religious conceptions, mythology, and traditions; their mental traits and development; their civil and political organizations and institutions; their language, literature, arts, and monuments; their customs and modes of life. This statement may seem sufficiently comprehensive, yet it is really incomplete, and, in fact, hardly touches a whole tract of inquiry, which Prof. Huxley regards as the principal thing. According to his definition, "anthropology is the great science which unravels the complexities of human structure; traces out the relations of man to other animals; studies all that is human in the mode in which man's complex functions are performed; and searches after the conditions which have determined his presence in the world. And anthropology is a section of *Zoology*, which again is the animal half of *Biology*—the science of life and living things."

*Ethnology* is a branch of anthropology, and is defined as the science of races. The family of mankind is divided up into great groups, which are characterized by numerous and important differences; it is the business of ethnology to trace these differential characters, to estimate their value, and, if possible, to ascertain their source. The ethnologists are divided into two schools: one school holds to the theory of *monogenesis*, or that the human race has had a single origin, or sprung from a single ancestral pair; and the other school holds to the theory of *polygenesis*, or plurality of origins. These schools, of course, take different views of the nature and character of the differences among races. Those who maintain that racial differences have been brought about by natural causes, speak of races as "modified men," and it is with reference to this idea that Prof. Huxley defines the science. He says: "Ethnology is the science which determines the distinctive characters of the persistent modifications of mankind, which ascertains the distribution of those modifications in present and past times, and seeks to discover the causes or conditions of existence, both of the modifications and of their distribution. I say 'persistent' modifications, because, unless incidentally, ethnology has nothing to do with chance and transitory peculiarities of human structure. And I speak of 'persistent modifications,' or 'stocks,' rather than of 'varieties,' or 'races,' or 'species,' because each of these last well-known terms implies, on the part of its employer, a preconceived opinion touching one of these problems, the solution of which is the ultimate object of the science; and, in regard to which, therefore, ethnologists are especially bound to keep their minds open, and their judgments freely balanced."

It is obvious that ethnology covers a large field in the domain of anthropology, and it in fact involves so much of the larger subject that there has been found great practical difficulty in pursuing them separately. The larger subject is the later in the order of cultivation. Ethnological societies were the first to be formed in Paris, London, and New York, but they have disappeared in their distinctive forms, and are now merged in organizations for the promotion of anthropological knowledge. This, however, is but a matter of practical convenience, for the spirit and methods of investigation in both are essentially the same. It is the aim of this science, to study man as all other parts of Nature are studied, with the simple aim of ascertaining and classifying the facts. Putting aside all preconceived views that might vitiate the strict scientific character of the inquiry, the anthropologist asks simply: What are the phenomena presented by the different groups of men? What are their aspects, modes of life,

beliefs, traditions, institutions? In short, what are the data which, when authentically presented, will serve as the basis for generalizations respecting the attributes and nature of man?

We publish, in the present number of the MONTHLY, an interesting ethnological sketch of the Calmucks of the Volga. It is translated from the Russian, and is derived from the work of Nebalsine, who resided for a long time at Astrakhan, at the mouth of the Volga, on the Caspian Sea, and he was employed at the "Court of Domains," by which these singular people are governed. At this place he had opportunity to study them carefully and intimately. No Mongol or Turkish race presents such characteristic traits as the Calmucks. They display the persistence of race character in a remarkable degree; answering exactly to the description given of them by Jornandez thirteen centuries ago, when, under the name of Huns, they devastated Southern Europe. Chambers describes the Calmuck as short in stature, with broad shoulders, a large head, small black eyes, always appearing to be half shut, and slanting downward toward the nose, which is flat with wide nostrils, hair black, coarse, and straight, complexion deeply swarthy, while his ugliness is the index of the purity of his descent. The beliefs of the Calmucks, as represented in the article, form an instructive comment on the dogma of the "wisdom of the East."

It is not to be supposed, however, that the wisdom of the West would at all approve the life of these restless nomadic vagrants. They would be told to settle down somewhere, change their religion, go to work, build schoolhouses, and make money, like good Christians. It is, however, probable that the Calmucks would not be without a reply. A traveller, who had studied their customs, made this significant statement: "If it could be proposed to all the academies of Europe to point out the best means to convert those enormous and sterile deserts, which are completely lost for agriculture, into habitable and productive lands, they would with difficulty find a more practical solution of this problem, than that actually put in operation by the Calmucks themselves. In fact, with these poor herbs, so thin and so arid, which they find in these enormous wastes burnt up by the sun, the Calmucks nourish millions of horses, cows, goats, sheep, and camels, and transform these sterile districts into a true and rich source of wealth to Russia. By making a great trade of wool, hair, fat, skins, and pelts, the Calmucks contribute to furnish illumination and defence against cold to a great portion of the northern provinces of the empire. In this particular, the economic part played by the Calmucks is very important."

## LITERARY NOTICES.

THEORY OF HEAT. By J. Clerk Maxwell, M. A., F. R. S. D. Appleton & Co.

IT is only recently that the general public has been admitted to a knowledge of the researches which are carried on by the leading physicists of the world. Perhaps an educator would consider the desire of the public to be so admitted one of the most encouraging signs of the times, and he undoubtedly would hail the fellowship of the scientists and their audiences as a good omen. It is a very interesting phenomenon which we are now called upon, almost daily, to witness—this affiliation of the student and the public; and it has many good features, as well as some bad ones. Among the good there are the obvious ones of the acquisition of mere knowledge, of the acquaintance with the rigid and exacting logic of the physicists, of the perception of the real beauty in the order and harmony of Nature, and the familiarity with daring thought which stops short of wild speculation, and displays that poise of intellect which is a striking characteristic of the modern school. And, so far, we have noticed only

the good points of this intimacy, which indeed is a novel one.

The scientific man of to-day has a large and attentive audience; and, except he be a devotee to the more abstract of the sciences, he is sure of immediate praise. This, too, is a good result from the close connection. But the effect has been, partly, to make the scientist speak in a manner almost too elementary; in endeavoring to make all things plain, he has been obliged to hide the very highest of his researches, because their demonstration has required too great a stretch of intellect from his hearers.

This has been, partly, inseparate from the form of instruction by lectures, in which form it is, of course, impossible to obtain much close attention to the more complex of his truths, which only allow themselves to be stated in mathematical symbols. We may assume the public of a scientist like Tyndall or Huxley to be composed of three classes: 1. Of scientists themselves, who can and must consult their original memoirs, and who have besides the power to supply any lacunæ in reasoning; 2. Of the general public; and, 3. Of a large and important class of young men, students, to whom science is a cultivator, and who desire didactic treatises which shall give concisely and rigorously the essence of a subject, and which shall not require them to consult publications of scientific societies, which works are often beyond their reach, and to which, at any rate, but few would go.

It is, therefore, with real gratitude that we must look to Prof. Maxwell for his essay on the Theory of Heat.

It fills, exactly, a place before vacant. By it we are led in a logical order, which is very beautiful, from the simple idea of *temperature*, through the *registration* of this *temperature*, and finally to the complex idea of the *measure* of *heat*. From this point an analysis of the book would be almost a history of the development of the science. The subjects of isothermals and adiabatics are fully treated, and the elementary principles of heat engines are stated and proved.

While all this is done, so that a young student, with due attention, may follow the argument, we warn him that the book is no child's play. There are no useless words spent on explanations, but enough is left to keep his mind clear and busy. And it is here, too, that we may speak of the admirable manner of the book which is rigorous throughout. It is an excellent preparation, too, to the memoirs of Clausius, whose mathematical essays are the acknowledged classics on the subject of heat, and who still leads us in the most startling way and at once to differential equations, as if they were our daily bread.

We are sure that there is no one who will not read Clausius "On the Steam-Engine" with much greater ease for having previously read this little book of 312 pages. The foundations of thermodynamics are laid in a simple way; and the chapters on intrinsic energy, on radiation, and on viscosity, are models of their kind.

It is, indeed, to Prof. Maxwell that we owe a beautiful essay on this last subject, mathematical in form, which is printed in the proceedings of the Royal Society. There is also in this volume a discussion of the molecular constitution of bodies, which contains much that is valuable, particularly as an introduction to the various advanced essays on the same interesting topic.

The volume is of a handy size, and is fairly well printed, and there are fewer blemishes in it than in any other of its kind. We notice on pages 139, 152, and 183 (second edition), a looseness which a little more care might have avoided.

On page 139, the author, in speaking of Carnot's reversible engine, says, "It is of a species entirely imaginary, one which it is impossible to construct, but very easy to understand;" thus putting it as a theoretical device solely, as he ought. Again, on page 152 our author proves, or intends to prove, that this engine has a greater efficiency than any other engine, which he attempts to do by an appeal to ordinary experience, which he cites to show that no real working engine "can convert the entire heat of its parts into work," even if this engine consists in part of the theoretical Carnot reversible engine. Now, he has not proved this of any engine, except of those actually in use, and he has expressly declared, as above, that the Carnot engine cannot be made: so that his proof falls to the ground. And, to make matters worse, on page 183 he says: "If we possessed a perfect reversible

engine and a refrigerator at the absolute zero of temperature, we might convert the whole of the heat which escapes from the body into mechanical work." On pages 99 and 100 we have a similar carelessness, in the use of the term *strain:* this is defined on page 99 to mean "the alteration of form of any body;" while on page 100 he speaks of the "product of the strain into the average value of the stress," i. e., of the product of a force into a change in shape, which of course is a misnomer, and could be corrected by interpolating the phrase *in any direction* after "strain."

There are but few of even such errors as these, and we must welcome the book as a most valuable one, in which the golden mean between too great simplicity and too great difficulty is admirably kept; and in the name of the ordinary student we are thankful to Prof. Maxwell for his most admirable essay. E. S. H.

How Plants behave. By Asa Gray. New York: Ivison, Blakeman & Taylor.

Fourteen years ago, Prof. Gray published a little school-book, entitled "How Plants grow," which was designed as a first step, for young people and common schools, of his excellent series of botanical text-books. The present volume of forty-six pages, "How Plants behave," is Part II., or a continuation of "How Plants grow," and is devoted to a description of certain remarkable actions and effects in the vegetable kingdom which are open to familiar inspection. The author's object in the preparation of these little works is thus stated in his preface:

"That young people, that all students, indeed, should be taught to observe, and should study Nature at sight, is a trite remark of the day. But it is only when they are using the mind's eye as well, and raising their conceptions to the relations and adaptations of things, that they are either learning science or receiving the full educational benefit of such a study as Botany or any other department of Natural History.

"There is a study of plants and flowers admirably adapted, while exciting a lively curiosity, to stimulate both observation and thought, to which I have long wished to introduce pupils of an early age. The time has now arrived in which I may make the attempt, and may ask young people to consider not only, 'How Plants grow,' but how plants act in certain important respects, easy to be observed—everywhere open to observation, but (like other common things and common doings) very seldom seen or attended to. This little treatise, designed to open the way for the young student into this new, and, I trust, attractive field, may be regarded as a supplement to the now well-known book, the title of which is cited at the beginning of this prefatory note. If my expectations are fulfilled, it will add some very interesting chapters to the popular history of plant-life.

"Although written with a view to elementary instruction, and therefore with all practicable plainness, the subjects here presented are likely to be as novel, and perhaps as interesting, to older as to young readers."

Prof. Gray has well succeeded in his purpose, and the pages of his little book are full of interest to all who care for the curiosities of the vegetable world. His volume is divided into three chapters. The first shows how plants move and climb and take positions; the second tells how plants employ insects to work for them; and the third describes how certain plants capture insects. Among all the surprising effects presented by natural objects, none are more curiously interesting than the habits and adaptations of vegetable structures, and Prof. Gray tells the story in his own clear and graphic way. The pages of his little book are full of pleasant information, and cannot fail to be instructive; and, if the pupils are attracted to go beyond its pages to examine for themselves the structures and actions described, the experience will be invaluable as a cultivation of the observing powers.

## MISCELLANY.

**Death of Dr. Stimpson.**—In the recent death of Dr. William Stimpson, secretary of the Chicago Academy of Sciences, American science has suffered an irreparable loss. He was born near Boston, February 14, 1832, and was drawn by a strong impulse to the study of science in his boyhood. His

chosen field was natural history, and before he was nineteen, at which age he published his first scientific paper on conchology, he had made extensive collections. In his search for specimens at the bottom of the sea, he pushed out into deep water and claimed to be the first to enter upon the work of deep-sea dredging. He studied with Agassiz, and in 1852 accompanied him to Norfolk to investigate the marine fauna of that region. He was appointed naturalist to the North-Pacific Exploring Expedition, and spent three and a half years (1852–1856) in observations and collections. For nine years after his return, he remained for the most part in the Smithsonian Institution, working up the results of his world-wide explorations. He became curator of the Chicago Academy of Sciences in 1864, and was soon after elected secretary.

In an able obituary address before the Chicago Academy, President Foster has enumerated his chief contributions to science, and thus speaks of his labors in the institution:

He maintained a correspondence with not less than fourteen kindred societies at home and over one hundred abroad. He organized a system of exchanges by which our library was supplied with the scientific journals and Transactions, and our museum enriched with natural-history specimens from every quarter of the globe. He edited, with an accuracy of proof-reading rarely surpassed, the two parts of our Transactions, and prepared our annual reports with an almost commercial exactness. So thoroughly classified were the collections, that he could instantly refer the scientific inquirer to the particular specimen required. Under his directorship, the collections in certain departments of natural history had grown to be the most complete in the country; and learned foreigners, in pursuit of information, resorted here as to one of the chosen seats of science. This vast collection had been accumulated within the short space of five years; for, on the 7th of June, 1866, our previous accumulations were almost wholly destroyed by fire. Under this calamity Stimpson bore up manfully, but when the tremendous catastrophe of the 8th of October occurred he was, as it were, crushed to earth. From that time, I think, his spirit lost its buoyancy; and, while he assumed an air of cheerfulness, in his quivering lip and tremulous voice it was easy to detect what he would fain conceal. The iron had entered his soul. Let him who would accuse our friend of undue weakness, read over the melancholy catalogue of losses prepared by the secretary, and dated the 30th of October last, and then call to mind that, in addition to the total destruction of the Academy's collections, which he had arranged and classified, his own collections had been involved in the general calamity; rare books, obtained with difficulty, or presentation copies bearing the autographs of the authors; shells which he had dredged from the ocean all the way from Nova Scotia to the Japanese Sea; and manuscripts in which were embodied the results of twenty years of almost unremitting scientific labor, and whose publication he fondly hoped would form the solid basis of his fame.

Dr. Stimpson had long suffered from weakness of the lungs, and died of hemorrhage May 26, 1872, aged 41.

**Purification of Coal-Gas.**—In the ordinary process of manufacturing coal-gas it is found necessary to put the product through a course of purification before it is fit for illuminating purposes. The sulphur compounds are the most deleterious of its impurities, and how these may be best removed forms the subject of an instructive lecture, recently delivered by Mr. Vernon Harcourt at the Royal Institution, from which we condense the following: Sulphur being an almost constant constituent of the coal from which gas is made, it is volatilized in the retorts and passes over with the gas in combination with its two principal elements, carbon and hydrogen. Unpurified coal-gas thus contains sulphuretted hydrogen—the gas of rotten eggs—and bisulphide of carbon. A considerable part of the sulphuretted hydrogen is removed in the "condensers" and "scrubbers" by the action of water and ammonia. It has, however, been found that, if coal-gas is washed too much, its illuminating power is greatly impaired, and indeed all washing does some injury to it in this respect. To complete the removal of sulphuretted hydrogen, the washed coal-gas is passed through large boxes, containing either lime or oxide of iron, and which are termed purifiers. Either of these substances acts very effectually in depriving coal-gas of its sulphuretted hydrogen. Lime is the cheaper material, but has the serious drawback that when saturated with sulphuretted hydrogen its smell is very offensive, so that when taken out of the purifiers it becomes

a nuisance of a very obnoxious character. Oxide of iron absorbs sulphuretted hydrogen equally well, and has the great superiority that, when taken out of the purifiers and exposed to the air, it not only creates no nuisance, but becomes in a short time fit to be used again. The same oxide may thus be used over and over again for twenty times or more, and when it becomes unfit for the purifiers it is still more valuable on account of the quantity of sulphur it contains.

But neither lime nor oxide of iron exerts any action on the other sulphur impurity, the compound of sulphur and carbon, and at the present time this bisulphide of carbon remains in the gas without any attempt being made to remove it.

The bisulphide of carbon, when burnt, forms for the most part sulphurous acid, which, being a gas, is removed with the carbonic acid by efficient ventilation. But a small part of the sulphur in this compound is converted into sulphuric acid, which, with the aqueous vapor formed, condenses on the walls of the apartments, and has been proved to destroy the leather bindings of books, and the canvas of pictures.

If coal-gas is to be burnt in rooms as freely as oil or candles, it is absolutely essential that the amount of sulphur it contains should be reduced to the smallest possible quantity.

One means by which the elimination of sulphur may be achieved, a process by which the amount of sulphur may be brought down to one-fifth of the present legal maximum, namely, 30 grains in 100 cubic feet, is the following:

The coal-gas is made to pass through tubes which are filled with fragments of iron and heated to redness. When dry hydrogen, contaminated with the vapor of bisulphide of carbon, is passed through a heated glass tube, carbon is deposited, and sulphuretted hydrogen is produced. The action is precisely the same when coal-gas containing bisulphide of carbon is made to pass over strongly-heated surfaces; the bisulphide is decomposed, and sulphuretted hydrogen formed, which is speedily removed by the ordinary purifying apparatus.

Mr. Harcourt showed, by means of a jet-photometer, that there was no appreciable difference in illuminating power between the coal-gas which had passed through an iron tube filled with nails and heated to redness, and that of ordinary cannel-coal gas. He also demonstrated the truth of his statement that, after being thus treated, but one-fifth the quantity of sulphur remained that is found in common illuminating gas.

**Facts in relation to Rainfall.** — From observations at Fulwell, near Twickenham, England, it appears that the rainfall for that locality during the year 1871 was 22.42 inches. This is nearly the amount which falls at Paris and at San Francisco, California. A calculation made by John James Hall, which was published in *Nature*, April 18th, and corrected in a subsequent number, gives some interesting statistics of the rainfall at Fulwell:

He states that one inch upon an acre of ground gives 22,623 gallons. Now, 640 times this amount, multiplied by the depth of rainfall, 22.42 inches, gives the quantity on a square mile as 324,612,902 gallons.

If this amount be multiplied by 10, the number of pounds of water to the gallon, and the result divided by 2,000 for tons, we shall have, for the quantity of rainfall on the square mile, nearly 1,623,064 tons.

The coal-carriages used on railways in England and in the United States carry from 8 to 10 tons of coal each. We will assume the former number, and find that 202,883 such carriages would be required to convey the weight of the rainfall above given, and, if each carriage measures 20 feet in length, they would form a train 768 miles long.

The quantity of rain which falls at Flatbush, Long Island, in the immediate vicinity of New York City, is 43 inches yearly. This is based upon observations made during 26 years. It will be seen that this amount is nearly twice as great as that which falls in a year at Fulwell, and is not far from the annual average that falls on our coast from Maine to Florida.

The computation which gives the results for Fulwell will give the quantity for each square mile of our own coast. For Flatbush, with an annual rainfall of 43 inches, we have the enormous quantity of 622,594,960 gallons nearly, or 3,112,974 tons of 2,000

pounds each. This is just about one-half the estimated weight of the largest of the pyramids. To convey this amount by railway carriages, of 8 tons each capacity, would require 389,121 carriages, and, if of 20 feet length, they would make a train 1,473 miles long.

When we consider that for each year and upon each square mile of surface along our ocean border, and many miles inland, so vast a volume of water falls, we are astonished at the grandeur and vastness of some of the most common of the operations of Nature.

**Prof. Agassiz's South-American Observations.** — Prof. Agassiz and his scientific party are continuing their explorations of the South-American coast, in the steamer Hassler, and the professor has just made a second report to the Superintendent of the Coast Survey on the progress of his observations. As is well known, Prof. Agassiz undertook this expedition to accumulate evidence in regard to the extent of glacial action in producing geological effects. He has been a student of glaciers for forty years, grew up in a glacial region, and is familiar with the phenomena; early framed a theory upon the subject, and felt so certain of the truth of his views, that he predicted with great confidence the results of the explorations now undertaken. He says: "As soon as geologists have learned to appreciate the extent to which our globe has been covered and fashioned by ice, they may be less inclined to advocate changes of level between land and sea, wherever they meet with the evidence of the action of water, especially where no marine remains of any kind mark the presence of the sea." He confirms many of Darwin's observations made in the same region thirty years ago, but thinks he ascribed too much to the agency of upheavals. Nevertheless, he discovered a salt-pool with marine animals, in the interior, near Possession Bay, which were undoubtedly due to upheaval. He says:

About a mile from the shore bluff, I found, nearly 150 feet above the sea-level, a salt-pool, in which, to my great surprise, marine shells, identical with those now living along the shore, were abundant. They were in a perfect state of preservation, and many of them were alive; so that I gathered a number of specimens with the living animal, which I have preserved in alcohol. The most common were ferns, myrtilus, buccinum, fissurella, putella, voluta, etc., all found in apparently the same numeric relation as that in which they now exist in the sea below the cliff. The presence of this pool, with its living inhabitants, shows a very recent upheaval of the coast. The period at which it may have taken place it is hardly possible to determine without a more extensive survey.

But these and other evidences of upheaval do not disturb his profound conviction that ice has been the grand agency by which the southern continent has been moulded, as appears from the following:

It was not till we rounded Cape Froward that I felt confident that the range of hills immediately in sight along the channel we followed had assumed their present appearance in consequence of abrasion by ice. Now, however, that I have seen the whole length of the Straits of Magellan, have passed through Smyth's Channel, and visited Chiloe, I am prepared to maintain that the whole southern extremity of the American Continent has been uniformly moulded by a continuous sheet of ice. Everywhere we saw the rounded, undulating forms so well known to the students of glacial phenomena as *roches moutonnées*, combined with the polished surfaces scored by grooves and furrows, running in one and the same direction; while rocks of unequal hardness, dikes traversing other rocks, slates on edges, were all cut to one level. In short, the surface features of the Straits of Magellan have much the same aspect as the glaciated surfaces of the Northern Hemisphere. Whenever the furrows and scratches were well preserved, their trend was northern.

**Notes on the Seychelles Islands.** — In August, 1871, Nicholas Pike, Esq., U. S. consul at Mauritius, visited the Seychelles Islands, a group lying 900 miles northeast of Mauritius, in the Indian Ocean. They are 29 in number, some of them mountainous, comprising about 50,000 acres of land, and lie between 3° 33′ and 5° 45′ south latitude. Most of them are covered with tropical vegetation.

The shores are fringed with coral-reefs in all places favorable to their growth. Gigantic astræas, brain-corals, madrepores, and coral shrubbery of many hues, cover the reefs of which they form a part.

Consul Pike visited many of the islands and made an interesting sketch of their nat-

ural history, which has been published in pamphlet form at Port Louis. Landing at Mahé, he penetrated inland, and found upon the slopes of the hills groves of the jamrosa and the guava-tree.

The jamrosa is the favorite food of the curious leaf-fly (*Phyllium siccifolium*).

The peculiar dress of this insect enables it to elude the pursuit of the uninitiated. In form they imitate various leaves, and the resemblance is the more striking from the peculiar veining of their wings. They are sometimes over three inches in length, and their legs have curious leaf-like expansions. They hide on the under surface of leaves, and, when disturbed, double themselves up, so as to closely resemble crumpled leaflets. Probably no more perfect illustration of protective resemblance and mimicry is afforded by the animal kingdom, than by this little insect.

Scorpions abound on the islands, but are less dangerous and dreaded than a large spider of the genus *Phyrnus*. The female of the species, so plenty on the islands, is one-third larger than the male, being about fourteen lines long.

The many-jointed forelegs are of exceeding tenuity, and measure five inches in length.

These spiders attack by springing on their victim, and their bite causes inflammation, sometimes cramp, vomiting and swelling of the whole body. Ammonia is used by the natives as an antidote for their poison.

A species of mason wasp swarms on the islands, and intrudes everywhere. It builds in houses upon suspended strings, in caves, and in every accessible nook.

It is of a bright-brown color and about one and a quarter inch long. Their cells are about half an inch in length, and built of red mud. Like many species of their class in other parts of the world, they have a curious instinct for preparing food for their young, when in the larva state. After the egg is deposited in the cell, it is carefully filled with small spiders, and closed. The spiders are probably paralyzed by being stung. They continue fresh for several weeks, even retaining their natural colors, and afford the necessary food for the young larva.

The author gives a most interesting account of the wonderful palm-tree, the *coco de mer*. A century ago it was abundant on these islands, now it has nearly disappeared. For one of the nuts of this tree, it is said that the Emperor Rudolph offered 4,000 florins.

These nuts resemble the cocoa-nut in some respects, but are two-lobed, and four or five times larger.

A fine specimen forwarded by Consul Pike to the Long Island Historical Society of Brooklyn, N. Y., is now in its Museum of Natural History.

The tree grows sometimes a hundred feet high, with a slender stem and a ragged head of green and withered leaves. When the young plant attains the age of 20 or 25 years, and before fructification commences, the leaves have attained their greatest size and luxuriance. The stem then begins to rise.

It is nine months after planting before the germ begins to shoot; then, instead of rising directly, it shoots away like a root 15 or 20 feet, when it rises above the surface. Each leaf requires a year's elaboration in sun and air before the next appears. The early Dutch and Portuguese explorers found the immense nuts of this palm floating in the sea, and supposed it to be an ocean product, hence its name *coco de mer*.

**Elevation of Lagoon Islands in the Pacific.**—At a meeting of the Geological Society of London, held May 8th, Mr. D. Forbes is reported to have said that, "when in 1859 he spent some months in the Pacific, he had been requested by Mr. Darwin to examine into the evidence as to the origin of atolls by elevation, and had found that the asserted cases of the existence of masses of coral at a considerable elevation above the sea merely arose from blocks having been transported inland by the natives."

He, however, thought it possible that elevations had taken place in some instances.

The report, which is given in *Nature* for May 23d, undoubtedly fails, on account of its brevity, to express clearly the remarks and meaning of that eminent naturalist.

It is, we believe, conceded that the observations of Prof. Dana among the coral-islands of the Pacific are thorough and accurate. On pages 345 and 346 of his re-

cently-published work on "Corals and Coral Islands" is given a catalogue of about forty islands in the Pacific which have been more or less elevated since the formation of their reefs. Of these, several are lagoon islands.

Penrhyn's Island has an extensive lagoon and a total elevation of 50 feet above the sea.

Tongatabu and Hapaii are elevated atolls of coral; both have lagoons; the one on Hapaii is now a salt lake 1½ mile long.

Of the elevated islands as given by Prof. Dana, the amount of elevation is from one or two feet to 600 feet in two instances.

The island of Mengaia is girted by a coral-reef 300 feet high.

Others have 25 feet, 60 feet, 90 feet, and 300 feet of elevation.

These reefs were formed as reefs are now being formed, near the surface of the ocean, and their great thickness is accounted for by long but slow subsidence of the land. But it is equally certain that important elevations must have followed in the instances given of elevated atolls and reefs. It is not contended that the elevation is as general as the subsidence was. Nevertheless, instances of elevation occur in various parts of the Pacific, but the amount is not uniform even with islands not very distant from each other. The fact appears to be, that in some cases single islands, in others groups of islands, as the Gilbert Group and part of the Tonga Islands, have risen after an indefinite period of subsidence, and this seems so well established as to be scarcely open for discussion.

**Chloral-Hydrate in Hydrophobia.**—The *Lancet* for April 20th contains an interesting account of a case of hydrophobia, where the disease was controlled, and terminated in recovery, under the use of hydrate of chloral. The patient was an active business-man, about forty years old, who had been bitten on the hand by his own dog some four or five months previous to the attack. The wound was cauterized at the time, and little more thought of it, until about a fortnight before the disease developed.

The patient states that he first felt a pricking sensation about that part of the hand which had been bitten, followed in two or three days by swelling, and a pain striking up the whole arm, which afterward became numb. He thought it was rheumatism. These symptoms increased, and he began to decline in health. His appetite failed; he had chills and heats, with an occasional headache; felt confused, anxious, and irritable; was easily startled and alarmed. When walking along the streets he would suddenly stop or turn round, and did not know the reason why. If a bird flew out of a hedge, or any unusual noise occurred, he felt agitated. When at chapel the Sunday previous to his being laid up, he experienced a sudden impulse to spring forward and jump over the front of the pew, and he restrained himself from the attempt by laying hold of the seat with both hands. The attack was characterized by the usual hydrophobic symptoms, great difficulty of breathing and of swallowing, distress at the pit of the stomach, convulsions, frightful struggling and howling, wild expression of countenance, frothy discharge from the mouth, and on one occasion a strong propensity to bite. The paroxysms succeeded each other at intervals of about ten minutes, and perceptibly grew worse as they continued. Shortly after being called in, the attending physician, who relates the case, began the administration of chloral-hydrate in twenty-grain doses. After the third dose, the violence of the symptoms began to moderate; the fourth dose was followed by still greater improvement, and the fifth dose put the sufferer to sleep. This soporific effect was kept up by giving the same dose of the chloral at longer intervals. For the next twenty-four hours nothing of any consequence occurred, with the exception of slight twitchings of the face and jerkings of the arms and legs during sleep. These were allayed at any time by an extra dose of the chloral. Beef-tea, mutton-broth, common tea, or water-gruel, was given him occasionally, which he swallowed without much objection when fairly roused up. During the next three days the somnolency was kept up by the medicine, with only a few twitchings showing themselves. On the morning of the fifth day he awoke out of a gentle slumber, and said to his wife, "I feel as if I should like to bite somebody." This was the last symptom

noticed of a hydrophobic character. After the fifth day the chloral-hydrate was discontinued, and the quantity taken altogether amounted to 360 grains. When fit to travel, the patient went into the country, subsequently returning able to attend to business.

**Northern Exploring Expeditions.**—According to a correspondent of the *London Daily News*, four expeditions are now on their way or about to start from different ports in Europe for the north-pole. The Swedish Government sends out one of these under the control of Prof. Nordenskiold, an experienced arctic explorer, who will attempt to reach the pole from high latitudes, by means of sleighs drawn by reindeer. The expedition takes with it a portable house, which is to be put up on the Seven Islands in latitude 80° 30′, the most northern point at which an expedition has ever wintered in these regions. Fifty reindeer are also to be taken along, together with the necessary fodder, and a number of Lapps to attend them. The scientific mission of the expedition is as follows: During the autumn the expedition will take soundings eastward of Spitzbergen; the eastern part of Spitzbergen is to be thoroughly surveyed; a series of continuous meteorological and magnetic observations for the space of an entire year are to be made; pendulum observations for determining the oblate form of the earth, refraction observations, besides a series of careful observations of the abundant animal life found in the Polar Ocean in these high regions. The scientific gain, it is expected, will be exceedingly valuable. The chief object will, however, be to attempt in the spring of 1873, after pushing as far as possible northward by vessel, to proceed, by sleighs drawn by reindeer, in the direction of the pole, and if possible to reach that point.

An Austrian expedition, which has the enthusiastic support of Dr. Petermann, is to set out about the end of June. The object of this expedition is the further exploration of the ice-free ocean, which they met with last summer, to the east and north, and the exploration of the Arctic Ocean to the north of Siberia. The plan of the voyage is as follows: The expedition being provisioned for a period of three years, the first winter is to be spent on Cape Tschelinskin, the most northern promontory of Asia; during the second summer the exploration of the Central Polar Ocean is to be continued, and an effort made to reach the pole; the second winter will be spent on the new Siberian Island, and the third summer will be employed in reaching Behring's Straits and an Asiatic or American haven. A third expedition, which is to act as a sort of tender to the last mentioned, is being fitted out by a certain Count Wilczek, who has already given largely in aid of northern exploration.

Two Norwegian fishing-steamers, under the command of able captains, are also, at the end of the fishing-season, intending to proceed in the direction taken by the Austrian expedition, and make explorations in the Siberian ice-sea, largely with an eye to future business.

A French expedition is also reported, which goes out under the direction of Gustave Ambert, who likewise proposes to follow the track of the Austrian vessel, with a view to "practical" as well as scientific results. Another French explorer, it is said, intends to get at the north-pole by way of balloon; but, how he is to obtain in that locality the supply of gas necessary to enable him to return and announce the discovery, is not stated.

**Preservation of Wood.**—Since the telegraph system of England came into the hands of the Government, active preparations have been going on for the very considerable extension of some of the lines An important part of the work is the treat ment of the poles for the purpose of preventing decay. Boucherie's process is the one employed. This was invented and largely used in France for the preservation of railroad ties and telegraph-poles, and is said to be both cheap and effective. It is thus applied by the English: The manufactory, as it may be termed, is situated in the middle of an extensive field, and consists, in the first place, of a quadrangular structure, four strong poles, some 60 feet in height, forming the angular points Within 6 feet of the top is a platform, on which are two or three vats, each capable of containing

200 gallons. In the bottom portion of this structure are pumps for the purpose of forcing a liquid, chemically prepared, into the vessels above. The principal ingredient, besides water, is sulphate of copper. From these vessels two systems of tubing are carried downward to the ground, and continued along the surface forward to a distance of a couple of hundred yards, in a direction at right angles to the front of the rectangular structure already mentioned. Raised at slight elevation from the ground, and placed at right angles to these tubes, lie the trees to be operated upon, with their thicker ends inward; at intervals of 12 or 15 inches, in this horizontal tubing, is placed a series of taps, each connected by a short India-rubber tube to the end of a tree, to which it is secured by means of cramps and screws, and rendered water-tight by a sort of nozzle. By means of cocks at the upper end of the horizontal piping, the solution in the vats is permitted to descend. The pressure exerted from above forces it into the pipes through the India-rubber tubing and into the trees, traversing them in the direction of their fibre. In a short time, the sap and a portion of the chemical solution are seen to ooze slowly from the smaller end of the tree, when it falls into a sort of wooden gutter, inclined at such an angle as causes it to run back to a cistern near to where it had been originally prepared. After undergoing some filtration here, it is placed along with the yet unused liquid, and again performs the circuit of the vats above and trees below. The time necessary for the complete saturation of the trees varies from ten days to three weeks, according to their quality and age. In this way an application of the principles of hydrodynamics, combined with what is little more than a mechanical chemical knowledge, enables the manufacturer to provide poles for telegraphic purposes which will resist the action of the atmosphere for at least five times as long as the telegraph-poles formerly in use.

**Propagation of Disease.**—At a late meeting of the Manchester Philosophical Society, the president, in some remarks on the propagation of disease, pointed out how this might occur through house-drains that emptied into sewers. The sewer, acting as a reservoir, receives the diseased emanations from one house, only to send them back through improperly-trapped drains into other houses. Proof of this being a possible mode of spreading disease was furnished by a case, where, in one of the streets of a town suffering from an epidemic of small-pox, several houses on one side of the street were visited by the disease, while on the other side every house escaped. This circumstance was all the more remarkable from the fact that, on the side affected, the yards and spaces about the houses were clean and dry, while on the other side "the privies and slops overflowed the yards and lanes, and the stench was almost unbearable." On the clean side, the houses were connected with the sewer, sewage-gas was within them, and so was the epidemic. On the dirty side, none of the houses communicated with the sewer, and all were free from the disease. "Thus untrapped or badly-trapped drains, terminating in sewers, may be worse than no drains at all."

**Detection of Alum in Bread.**—Anybody who wishes to test his bread or flour, for the presence of alum, may do so by the following process, which we find described and vouched for by Mr. John Horsley in a recent number of the *Chemical News*. First, make a tincture of logwood, by digesting, for eight hours, two drams of freshly-cut logwood-chips, in five ounces of methylated spirit, in a wide-mouthed phial, and filter. Second, make a saturated solution of carbonate of ammonia in distilled water. A teaspoonful of each solution mixed with a wineglassful of water, in a white-ware vessel, forms a pink-colored liquid. Bread containing alum, immersed in this liquid for five minutes or so, and then placed upon a plate to drain, will in an hour or two become blue on drying, but, if no alum is present, the pink color fades away. If, on drying, a greenish tinge appears, that is an indication of copper, as carbonate of ammonia produces that color, but never a blue.

**A Singing Marmot.**—Dr. Lockwood's theory of the latent singing capacity of the Rodents has received an interesting item of confirmation from an article in the June number of the *American Naturalist*, by Dr.

R. A. Kellogg, librarian of the Academy of Natural Sciences, San Francisco. He says that Dr. Lockwood's recent articles call out again a statement of his having a young Maryland marmot or woodchuck, when a boy, that "sung like a canary-bird, but in a softer, sweeter note." His impression was, that it was a female. "I used to watch the pet very closely to see how it sang, as children are apt to do. There was a slight motion of the nostrils and lips, and consequently of the whiskers, with an air of unmistakably happy or serene enjoyment."

**Is the Singing of Musical Mice labial or guttural?**—In answer to this question, which has been prompted by the reading of the article on musical mice in the last number of THE POPULAR SCIENCE MONTHLY, Dr. Lockwood says: "The sound is undoubtedly produced in the upper part of the throat, although, while singing, the lips and nostrils keep up that movement noticeable in the upper lip, so to speak, of the rabbit.

**The Rising of Circumpolar Land.**—Mr. H. H. Howorth, in a letter to *Nature*, summarizes the evidence in favor of the view that the lands about the north and south poles are undergoing general upheaval. Concerning the northern polar lands, he quotes Captain Parry to the effect that Melville Island shows unmistakable signs of elevation, in the presence of bones of whales and drift-wood buried in the sand, in some cases 15 or 20 feet above the present level of the sea. Franklin gives similar testimony concerning the coast extending from the Mackenzie River to the Rocky Mountains; while Dr. Richardson found a like state of things to the east. The narratives of Maclune and Belcher contain evidence of similar purport. Though generally spoken of as subsiding, the islands in the vicinity of Behring's Straits bear all the traces of having recently been under water. The eastern coast of Asia, including China and Japan, is also being upheaved. The rise of Spitzbergen was observed to be going on as long ago as 1646, and is again affirmed by Parry, in the account of his journey toward the pole.

Evidence of upheaval of lands adjacent to the southern pole is also abundant. In South America, Mr. Darwin found that "the land from the Rio Plata to Terra del Fuego, a distance of 1,200 miles, has been raised in mass (and in Patagonia to a height of between 300 and 400 feet) within the period of now-existing shells." Unmistakable evidences of upheaval are met with at Parana, on the banks of the Uruguay, and below Buenos Ayres. On the west coast in Central and Northern Chili, Mr. Darwin also found the indications of rising land.

Speaking of Southern Africa, Griesback says, "There cannot be the slightest doubt that the upheaval of the country is still going on; for, along the whole coast of South Africa from the Cape to Durham Bluff, and still farther north, even as far as Zanzibar, modern-raised beaches, coral-reefs, and oyster-banks, may everywhere be seen. At the Gzinhluzabalungu Caves is such a point; where the rising of the coast is plainly visible, recent oyster-shells are now 12 feet and more above high-water mark. The same can be observed on the whole line of the Natal Coast."

Of Tasmania Mr. Wintle remarks: "Until a very recent period in the geological annals of this island, a great portion of what now constitutes the site of this city was under water. This is proved by the extensive deposits of comminuted shells, all of recent species, which are met with for miles along the banks of the Derwent. Some of these deposits are at an elevation of upward of 100 feet above high-water mark, and from 50 to 100 yards from the water's edge, plainly showing thereby that a very recent elevation of the land has taken place."

In New Zealand the evidence is the same. M. Reclus says the port of Lyttelton has risen three feet since it was occupied by the settlers. Mr. Forbes says that proofs of upheaving of the land are even now obvious to any intelligent traveller. Some of these changes have been witnessed by the present generation. Again, in the Middle Island upheaval of the land is observable in a marked manner through the entire length of the western coast from Cape Farewell to Dusky Bay. Some of the most extraordinary changes in these regions have taken place within the last few years.

In Australia, the proofs that elevation is now taking place are equally clear and

abundant. "The whole coast round, to a distance of several miles inland, is covered with recent shells; the drainage of the country is apparently altering. Lakes known to have been formerly filled with salt water are now filling up with fresh or becoming dry. The lagoons near the coast are filled with salt and brackish water, and their banks are filled with marine shells with their colors in many cases preserved. Reefs of rocks are constantly appearing in places where there were none formerly. At Rivoli Bay the soundings have altered so much as to make a new survey requisite. A reef has lately almost closed this harbor. Other reefs have appeared at Cape Jaffa, etc. It would appear that a vast movement is taking place in the whole of the south of Australia. In Melbourne the observations of surveyors and engineers have all tended to confirm this remarkable fact."

From these and multitudes of other similar facts, Mr. Howorth concludes that the circumpolar land is rising about both poles, and that there is a general thrusting out of the earth's periphery, in the direction of its shorter axis. He also believes that an equally general subsidence is at the same time going on in the intervening region, extending both north and south of the equator, until it reaches the line of upheaval.

## NOTES.

PROF. TYNDALL remarks that the ordinary definition of the solid, liquid, and gaseous states, given in many text-books, is hardly correct. Cohesion is thought to be predominant in the first state of matter, absent in the second, and negative—that is to say, absolute repulsion exists among the molecules—in the third. But liquids may be strongly cohesive, and indeed the researches of many physicists have shown that there is not an absence of cohesion among, but sliding powers possessed by, the molecules of matter in the liquid state. If air is expelled from water, it is still liquid, but the cohesion of its molecules becomes very great.

A WRITER in the *Chemical News* states that iodine is set free in sea-water wherever rivers charged with offal and sewage meet the sea. Thus liberated, it passes into the atmosphere, and may sometimes be detected long distances away during the prevalence of favoring winds.

A CLERGYMAN, acting in the capacity of chaplain to a lunatic asylum in England, has for the last four years been engaged in the attempt to trace the relations that may exist between meteorological states and the mental and physical conditions of the insane. He states, as the results of his observations, that the accessions of epileptic fits have, as a very general rule, been preceded or accompanied by considerable alteration in atmospheric pressure, or solar radiation, or both; and he is led to the inference that it is not the moon, but the change in the weather, which directly affects epileptic patients. So far as his observation goes, he concludes that any marked change of atmospheric pressure, solar radiation, or both, either in the same or contrary directions, is almost certain to be followed by an increased number of fits among the epileptics, or by a development of mania or melancholia. Sometimes all three forms of disease are augmented at once, sometimes only one; and it is deserving of notice that very often the maniacal and melancholic patients seem to be affected in opposite ways, the latter being well when the former are excited, and the reverse.

THE following are the regulations adopted by the Prussian Chamber of Deputies to guard against the occurrence of steam-boiler explosions: 1. The owners or representatives are responsible for the observance of the laws and decrees laid down by the government. They are, moreover, not exonerated from culpability in case of accidents on account of ignorance of such technical laws and rules as are acknowledged by the profession. 2. The fine is fixed at a maximum of 200 thalers (£30), or, in case of default, three months' imprisonment. 3. The owners of steam-boilers must allow official tests to be made by competent engineers. They must bear the expense of the investigation, and furnish the examiners with all requisites.

DRS. EULENBERG and Wohl have been trying the effects of animal charcoal as an antidote for phosphorus-poisoning, and find it superior to any thing else heretofore employed. It is given in the form of pills made with gum-tragacanth; and is regarded as preferable to the oil of turpentine, which, though an effectual antidote against phosphorus, causes in many instances very severe headaches when taken internally.

THE temperance question, now much agitated in France, brings to the surface one ingenious reformer, Dr. Prosper Despine, whose zeal for the cause is at least equal to his discretion. He proposes to outlaw the growth of the grape, and to make the French abstemious by encouraging the

propagation of worms which destroy the roots of the vine. He would thus do away not alone with the vines, but also with the vanity of the French, for, says the *Saturday Review*, "it is impossible to conceive that vanity could remain in a nation whose salvation had been effected by so humble and earthy an instrument."

In many places in England they have for several years been using a safety-valve for steam-boilers that appears to be an absolute safeguard against explosions from low water. The valve is entirely within the boiler, and so rigged that when the water falls to a certain point the valve opens and a jet of steam is discharged upon the fires, the valve closing again when the water in the boiler is restored to its proper level. Being beyond reach, the valve cannot be tampered with, and, having its working-parts above high-water level in the boiler, it is not liable to get out of order from corrosion. Where these valves have been used, they have proved to be perfectly efficacious as a complete safeguard against explosion and collapse; and they are most highly spoken of, not only by steam-users, but also by inspecting engineers of boiler-insurance associations.

The greater the specific gravity of a gallon of oil, the greater will be the amount of light obtainable from it; or, in other words, a gallon of heavy oil, burning with a flame of given size and luminosity, will last longer than a gallon of lighter oil, burning in the same manner. The light oil is more volatile, passes off into vapor, and is consumed more rapidly; thus the most dangerous oils are the least economical.

In the *Jardin d'Acclimatation* at Strasbourg is a machine contrived for the fattening of fowls. The fowls are placed in a kind of dove-cot ranged in five different stages, each stage holding forty-two birds, which are separated from each other by vertical partitions, and which are so secured that their head and wings alone remain free. The "feeder" stands in front, and, taking the head of the bird in his left hand, forcibly introduces down its neck a quill which is in communication, by means of a hose of India-rubber, with a kind of reservoir full of the food beneath. The operator presses with his food upon this novel species of bellows, and a dial placed opposite to him registers the exact amount of food to a fraction of a cubic inch. The amount of this singular dose differs according to the age and species of the patient, as well as to the degree in which it is desired he should be fattened. In eighteen days a fowl can be brought to the point of fatness desired, and in certain very favorable cases the weight has actually been doubled in that time.

The Annual Meeting of the American Association for the Advancement of Science, which it was expected would be held in San Francisco, is to take place at Dubuque, Iowa, commencing on Wednesday, August 21st.

A remarkable instance of tolerance by the human system of the excessive use of tobacco is afforded in the case of M. Klaës, of Rotterdam. This gentleman, who was known as the "King of Smokers," has just died, in his eightieth year, and is said to have consumed during his long life more than four tons of tobacco. The ruling passion was apparent in the will of the deceased, and in his eccentric request that his oak coffin might be lined with the cedar of his old cigar-boxes, and that a box of French caporal and a packet of old Dutch tobacco might be placed at his foot, and by the side of his body his favorite pipe, together with matches, flint and steel, and tinder.—*Lancet.*

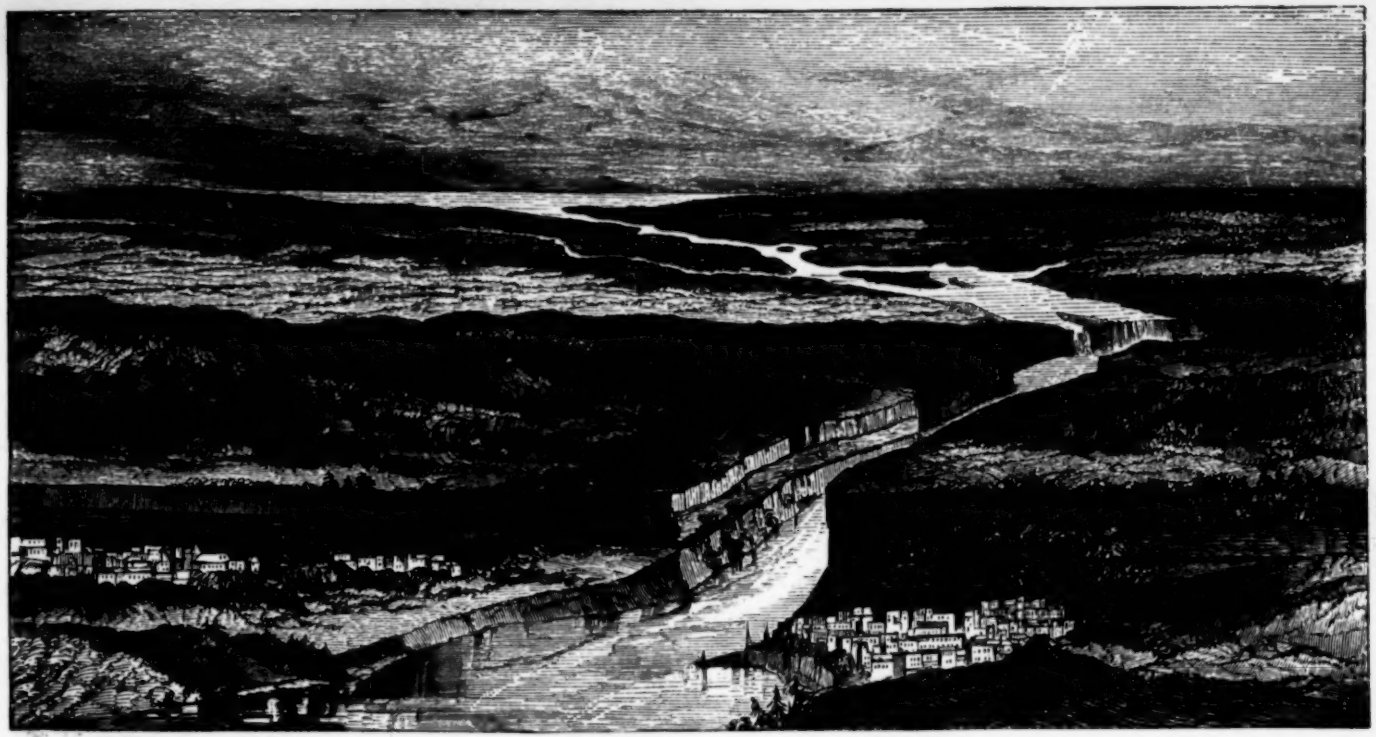
Dip the hand into a finger-glass until the water in it is warmed one degree. An amount of energy is withdrawn from that hand sufficient to project that water to a height of 772, or, if the degree be centigrade, to a height of 1,390 feet above the earth's surface — three times the height of St. Paul's.—*Tyndall.*

Caoutchouc is easily joined and made as strong as an original fabric, by softening it before a fire and laying the edges carefully together, without dust, dirt, or moisture between. The edges so joined must be freshly cut. Tubing can be made by joining the edges of a sheet of India-rubber round a glass cylinder, which has previously been covered with paper. After the glass is withdrawn the paper is easily removed. Sift flour or ashes through the tube to prevent the sides from adhering from accidental contact.

In a note to the Paris Academy of Sciences, on the influence which changes in barometric pressure exert upon the phenomena of life, M. Bent describes the effects produced by exposing small animals to various degrees of atmospheric pressure. He has found that, up to a pressure of two atmospheres, sparrows die when the air in the receiver contains 25 per cent. of carbonic acid, but that, above this limit, and below a pressure of ten inches, this law does not apply.

At the recent meeting of the French Departmental Learned Societies, held at the Sorbonne, gold medals were awarded to M. Grandidier, for his geographical, geological, meteorological, and botanical works, in particular of the island of Madagascar; and to M. Houzeau for his discoveries respecting ozone, which he is enabled to produce in large quantities.

LAKE ERIE. THE FALLS.




LEWISTON. NIAGARA RIVER. QUEENSTOWN.